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THE EDITOR'S VIEWPOINT

Crowley and Harner (p. 399) have studied the effect of penicillin on streptococci from saliva and from root canals. An interesting observation was that while *Streptococcus viridans* from infected root canals and from saliva were similar in their penicillin sensitivity, anhemolytic and hemolytic streptococci from saliva and root canals had markedly different reactions to penicillin. Of more direct clinical importance is the finding that *Streptococcus viridans* from root canals is sensitive to penicillin but that anhemolytic and hemolytic streptococci from root canals are resistant to penicillin.

Ostrander, Crowley and Dowson (p. 403) in a study correlated with that of Crowley and Harner, investigated the value of penicillin in root canal therapy. As might be surmised, on the basis of the laboratory study, since so many diseased root canals are infected by penicillin resistant organisms, the authors believed that penicillin was not a satisfactory treatment for root canals in many instances and pointed out that few dentists had the time or equipment to determine the organisms involved. Such studies as these reported in our first two papers for this issue of the JOURNAL should point the way in many other schools and institutions for correlated laboratory and clinical studies for evaluation of therapeutic and operative procedures.

Dreizen and Spies (p. 409), from the Nutrition Study Group at Birmingham, report on the possible inverse relationship between dental caries and periodontal disease in pellegrans. Two products of bacterial decomposition of tissue proteins, indole and indole-3-acetic acid partially inhibited lactobacilli in their growth and acid production. The importance of this study may lie in its relationship to the ammonia, as an inhibitor of dental caries.

Aisenberg (p. 421) shows by diagrams and photomicrographs that the attachment apparatus of the tooth adapts itself to altered conditions in many ways. Torn cementum, fractured teeth, internal resorptions and other injuries, may be repaired by readaption of the periodontium. It is suggested that teeth be treated for periodontal disease should be immediately subjected to functional stresses. We debated that term "functional stresses" but finally decided that Aisenberg was using the best term, i.e., a functional stress could not be excessive or reduced.

Manly and Brooks (p. 427) publish the results of an investigation of transparency and light scattering in dental tissues. They confirm an opinion held by dental histologists that dentin is transparent under attrition, abrasion, caries, in roots and in secondary dentin because of calcific deposits in tubules.

The Proceedings of the International Association for Dental Research (p. 435) present another historical record of dental research. There were 60 papers presented at the general sessions and 14 at the Dental Materials section sessions. An additional 27 papers were "read by title," a time-honored custom. The 101 titles present a panorama of dental research, today. Twenty-four universities, as well as state and federal health departments, the U. S. Army, the Bureau of Standards, and several commercial companies were represented on the program. The subjects included anatomy, chemistry, bacteriology, pathology, nutrition, histology, anthropology, physics, therapeutics, biometrics and statistics, fluorine, caries, periodontics, orthodontics, radiography, dentifrices, industrial hygiene and anesthesiology. Of the 60 papers read at the general sessions, 21 were authored or co-authored by past or present Rochester fellows. The president's inaugural address is a sign of the times—and most interesting. If you haven't seen the motion pictures of Able and Baker day see them and tell your friends to see them, somehow, someplace.

A communication from Commander

Schlack, Head of the Dental Branch, Medical Sciences Division of the Office of Naval Research, carries information on the development of Dental Division. At present, 5% of the funds of the Medical Sciences Division are assigned to dentistry. Eleven dental projects at 9 schools are now in progress. Further information is available from the Office of Naval Research, Navy Department, Washington, D. C.

A second edition of Brauer's *Dentistry for Children* (Philadelphia; Blakiston: 1947) has appeared under joint authorship of J. C. Brauer, L. B. Higley, M. Massler and I. Scour. The book is divided into two parts, one on basic considerations and the other on technical procedures. The basic discussions, as a whole, are well presented. We doubt the advisability of the statement that "In our experience, a tendency toward supernumerary tooth formation has sometimes been associated with the family history of tumor formation" being made by scientific contributors. Some similar personal impressions creep in without presentation of direct or indirect evidence. On the whole, the authors are to be congratulated on a fine correlation of laboratory and clinical practice. Many other authors, such as those in surgery that still report osteitis fibrosa cystica of unknown etiology, could well profit from this plan of correlation.

H. B. G. R.

PENICILLIN SENSITIVITY OF STREPTOCOCCI ISOLATED FROM ROOT CANAL INFECTIONS AND THE NORMAL MOUTH[1]

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Many workers have shown that certain strains of supposed penicillin-sensitive bacteria may be resistant to penicillin. Since a clinical study of the effect of penicillin in infected root canals was contemplated it was thought desirable to ascertain the sensitivity of individual strains of streptococci, which are the organisms commonly isolated from infected root canals. At the same time it was decided to determine the reactions to penicillin of streptococci from saliva of normal mouths. As it has been presumed that the streptococci causing root canal infections are usually derived from the saliva, the reactions of streptococci from the two sites might lead to some information on their relationship.

Material from infected root canals was inoculated into beef infusion semi-solid agar, containing ascitic fluid. The cultures after incubation at 37.5°C. for 36–48 hours were plated out on 2% blood agar. Single colonies of streptococci were then transferred to other blood agar plates to be studied. The reaction on blood was determined, and the streptococci classified as hemolytic, viridans or anhemolyticus. No other method or classification was attempted, since the viridans and anhemolytic types form such heterogenous groups that it was not thought expedient at this time to attempt further classification. The hemolytic group of streptococci are recovered in only 2% of infected root canals.

Streptococci from saliva were obtained from individuals who had no mouth infections. The saliva after collection was diluted with physiological salt solution, so that discrete colonies grew when streaked on blood agar. Single colonies were transferred to blood agar for study. No difficulty was encountered in identifying viridans type of streptococci, but difficulty was encountered with hemolytic and anhemolytic types of streptococci. It was noticed that colonies which had been picked as hemolytic types after replating, were anhemolytic in type; or that the anhemolytic type was hemolytic. At first it was thought that errors had been made in identifying colonies, but it happened so frequently, and after further precautions had been taken that we realized that we were dealing with dissociated strains, which had to be replated several times to obtain pure phase cultures. This particular problem is to be investigated in the near future.

Tryptose broth (1) containing 5% ascitic fluid, and penicillin sodium was used to carry out the penicillin sensitivity tests. Strains were tested in 0.03 U, 0.5 U. and 8 U. of penicillin per c.c. of broth. A positive control was made in the

[1] Read at the 25th General Meeting of the International Association for Dental Research, Chicago, June 21–22, 1947. (*J. D. Res.* **26**:455, 1947). Received for publication July 7, 1947.

same amount of broth, containing no penicillin. Each of the 4 tubes was then inoculated with 0.2 c.c. of an 18–24 broth culture. An especially penicillin-sensitive strain of *Streptococcus dysgalactiae* was used to inoculate the negative controls, which were always made with each set of tests. All tests were read after incubation at 37.5°C. for 18–24 hours.

The broth cultures from which inoculations were made, were plated out after tests were made to be sure no contamination or type changes had occurred.

If no growth occurred in any of the tubes containing penicillin, or if growth occurred only in the tube containing 0.03 U. per c.c. of penicillin, the strain was considered sensitive to penicillin. If growth occurred in both of the tubes containing 0.03 U. and 0.5 U. per c.c., and as sometimes was the case in the tube containing 8 U. per c.c., the strain being tested was considered resistant.

Tests were also read after 48–72 hours incubation but since the negative control

TABLE I

Penicillin in vitro reactions of streptococci

Source of streptococci	*Strep. viridans*				*Strep. anhemolyticus*				*Strep. hemolyticus*			
	Total tested	Resistant		Sensitive	Total tested	Resistant		Sensitive	Total tested	Resistant		Sensitive
		No.	%	No. %		No.	%	No. %		No.	%	No. %
Root Canals..	82	9	10.9	73 or 89.1	88	77	87.5	11 or 12.5	10	9	90	1 or 10
Saliva.....	26	3	11.6	23 or 88.4	13	3	23.1	10 or 76.9	21	0	0	21 or 100

containing 0.03 U. per c.c. of penicillin also grew the sensitivity of the organisms to penicillin was determined from the 24 hour reading.

RESULTS

Eighty-two strains of *Streptococcus viridans* were isolated from infected root canals (Table I). Of these only 9 (10.9%) were resistant to penicillin, while 73 (89.1%) were sensitive. Three (11.6%) of the 26 strains of *Streptococcus viridans* isolated from saliva were resistant, while 23 (88.4%) were sensitive. Statistical tests[2] showed that this small observed difference in penicillin sensitivity between *Streptococcus viridans* from the 2 sources was due to chanceal one. Eighty-eight strains of *Streptococcus anhemolyticus* were isolated from infected root canals. Seventy-seven (87.5%) were resistant, while only 11 (12.5%) were sensitive. This is in marked contrast to the reactions of the *Streptococcus viridans* from the same source, and also *Streptococcus anhemolyticus* isolated from saliva. Only 13 strains of *Streptocuccus anhemolyticus* from saliva were tested, of these 3 (23.1%) were resistant while 10 (76.9%) were sensitive. These differences were found to be quite highly statistically significant, even on the basis of as small a sample as 13. This study, though limited in scope, does indicate a real difference

[2] Miss Mabel Tramp, statistician at the School of Public Health, University of Michigan, made all the statistical studies.

in the reactions of the anhemolytic streptococci from infected root canals and saliva.

Only 10 strains of hemolytic streptococci were isolated from root canals. Nine (90%) of these were resistant. Only one (10%) was sensitive. Twenty-one strains of hemolytic streptococci were isolated from the saliva. All of these were sensitive. There were no resistant strains found in this group. This 0% presented some difficulty in applying a statistical test. However, it can be proved that a 0% based on a sample of 21, by chance alone, could have been as much as 10% or possibly even 15%. Even if as much as 15% instead of none of the 21 strains of hemolytic streptococci isolated from saliva had been sensitive, which could have happened merely by chance, the difference would still have been quite highly significant. A real difference is indicated by this experiment, in the reactions of hemolytic streptococci isolated from infected root canals and those isolated from saliva.

The results of 48 hour incubation of the streptococci isolated from root canals were interesting. Only 3 (3.6%) of the 82 strains of *Streptococcus viridans* grew in 8 U. of penicillin per c.c. after 48 hours incubation. None grew in 24 hours. Thirty (34%) of the 88 strains of Streptococcus anhemolyticus grew in 8 U. of penicillin after 48 hours incubation. Twelve (13.6%) grew after 24 hours. Three (30%) of the 10 strains of *Streptococcus hemolyticus* grew after 48 hours incubation. None of then grew after 24 hours.

None of the streptococci isolated from saliva grew in 8 U. of penicillin per c.c. at any time.

CONCLUSIONS

From these experiments it may be concluded that *Streptococcus viridans* from root canals is sensitive to penicillin. Anhemolytic and hemolyticus streptococci from root canals are resistant to penicillin.

The necessity of testing various strains to determine penicillin sensitivity is obvious.

Streptococcus viridans from infected root canals and saliva seem to be similar in relation to penicillin sensitivity.

The anhemolytic streptococci and hemolytic streptococci from infected root canals, and those from saliva are markedly different in their reactions to penicillin. However, further study is definitely recommended.

These differences may serve as a method, or at least give a clue to a method, for classifying the anhemolytic group of streptococci. Bornstein (2) used penicillin sensitivity to classify some types of streptococci. He reported "the method checks well with differentiations which have been made on a basis of physiological studies."

The results of these experiments lead one to doubt that the anhemolyticus and hemolytic streptococci from infected root canals are the same as those found predominating in the mouth.

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2. Bornstein, S., *J. Bact.*, **39**: 383-387, 1940.

A CLINICAL STUDY OF THE TREATMENT OF ROOT CANAL AND PERIAPICAL INFECTIONS WITH PENICILLIN[1]

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In the past two years a number of reports on the use of penicillin in the treatment of root canal and periapical infections have appeared in the literature (1–9). While most of the reports have indicated favorable results, there has been considerable variation in the degree of success and some of the reports have been inconclusive because of incomplete bacteriological controls.

PROCEDURE

Some preliminary clinical work was done at Michigan in which penicillin was used in the treatment of infected root canals, first in solution in physiological salt solution (5000 u. per c.c.) and later by use of absorbent points which had been saturated with 1000 u. of penicillin each. Results in a small series were unsatisfactory as compared to results obtained with commonly used drugs. Therefore, it was felt that if penicillin were to be used successfully some method must be found by which a large quantity of penicillin could be used in the tooth in a form that would slowly release penicillin over an extended period.

After some study it was found that by using a paste made up with penicillin, calcium carbonate and physiological salt solution it was possible to incorporate from 5000 to 10,000 units in the average root canal and pulp chamber and that the penicillin was slowly released over a period ranging up to 96 hours. This was confirmed by recovering absorbent points from penicillin-treated root canals after 24, 48, 72 and 96 hour intervals. These points were then placed in 5% blood agar plates with beef infusion broth base inoculated with a culture of *Streptococcus dysgalactiae*, an organism extremely sensitive to penicillin, as determined by Kakavas and Scott (10). After incubation for 48 hours it was found that all points showed significant areas of inhibited growth in the agar, thus indicating that effective quantities of penicillin were present up to 96 hours.

The clinical phase of this study was carried out by treatment of root canal cases in the clinic by exactly the same procedure as that routinely used, except for the substitution of penicillin for camphorated p. monochlorophenol or other commonly used drugs. Special precaution was taken to completely dry the canals of solution of sodium hypochlorite which is routinely used at each appointment for washing the root canals, since it would tend to inactivate the penicillin.

[1] Read at the 25th General meeting of the International Association for Dental Research, Chicago, June 21–22, 1947. (*J. D. Res.* **26**: 456, 1947). Received for publication July 9, 1947.

All work was done under rigidly aseptic conditions and cultures were taken in a beef infusion semi-solid medium with ascitic fluid immediately after opening the tooth and at each succeeding treatment, usually at 48 hour intervals. In those cases in which penicillin was used a duplicate culture was taken in the same medium to which 100 Schenley units of penicillinase per c.c. of medium had been added. This was done to eliminate the possibility that sufficient penicillin might be carried over from the tooth to the culture media to inhibit the growth of organisms.

Since it was felt that some of the variation in results reported from the use of penicillin in root canal therapy might well be due to the presence of resistant organisms in some teeth, a concurrent laboratory study of the penicillin sensitivity of the organisms isolated from the root canals was carried out.[2]

RESULTS

The results of this study are summarized in Tables I to V. In Table I it will be noted that 79 cases were treated with penicillin and of these 29 (36.7%) were sterile from the start and obviously gave no information as to penicillin effectiveness. In some previously reported studies it has been assumed that all cases were infected and initial cultures were not taken. This would obviously give an unduly favorable picture of the effectiveness of penicillin since several series of root canal cases studied at the University of Michigan have always shown from 35 to 50% of the cases to be non-infected, depending on the type of cases being studied.

Another group of 16 cases had to be eliminated from statistical consideration because they were accidentally contaminated, i.e., crown forms came off, cement fillings came out and in 2 instances acute exacerbations occurred which necessitated opening the tooth for drainage.

This left a group of 34 cases which were statistically significant. Of these, 20 responded to penicillin therapy with an average of 3.55 treatments to obtain 2 negative cultures while 14 did not respond to penicillin treatments and other drugs had to be substituted with an average of 7.77 treatments required. The average number of treatments for the series of 34 was 5.13 compared with an average of 3.76 treatments for a control series of 461 cases treated with commonly used drugs. Thus, when penicillin-sensitive organisms are present results with penicillin therapy are very favorable, but when resistant organisms are present, results are definitely inferior to those obtained with other drugs.

In Table II the effectiveness of penicillin in cases of *Streptococcus anhemolyticus* infections is compared with its effectiveness in cases of *Streptococcus viridans* infections. It will be noted that the results obtained very closely follow the pattern of penicillin sensitivity found "in vitro" by Crowley and Harner. Only 7 out of 18 (38.88%) of *Streptococcus anhemolyticus* infections yielded to penicillin therapy, which compares with an "in vitro" sensitivity of 12.5% while 12 out of 17 (70.58%) of *Streptococcus viridans* infections yielded to penicillin therapy compared to an "in vitro" sensitivity of 89.1%. Thus, there was a close

[2] Crowley, M. and Harner, V., *J. D. Res.* **26**: 399, 1947 (this issue).

correlation between penicillin sensitivity as determined in the laboratory and the clinical results.

Table III compares the effectiveness of penicillin with some other commonly used root canal antiseptics on the basis of the number of cases becoming sterile

TABLE I

Summary of penicillin study

	NO. CASES	% OF TOTAL CASES	% OF INFECTED CASES	AV. NO. TREATMENTS
Non-infected Cases	29	36.7		2.0
* Group I	16	20.2	32	8.07
† Group II	20	25.3	40	3.55
‡ Group III	14	17.7	28	7.77
§ Group IV	34			5.13
Control Series	461			3.76

* Group I—Cases eliminated from consideration because of accidental contamination.

† Group II—Cases which yielded to penicillin therapy.

‡ Group III—Cases which did not yield to penicillin therapy, but responded to other drugs.

§ Group IV—Groups II and III combined.

TABLE II

Bacteriology and penicillin effectiveness

	NO. CASES	% OF INFECTED CASES	NO. YIELDING TO PENICILLIN	% OF IN VITRO SENSITIVITY
Strep. anhem	*18	*52.94	7 (38.88%)	†12.5
Strep. viridans	17	50	12 (70.58%)	‡89.1

* One case was a mixed *Strep. viridans* and anhemolyticus infection.

† Based on laboratory tests of 88 strains isolated from root canals.

‡ Based on laboratory tests of 82 strains isolated from root canals.

TABLE III

Comparison of effectiveness of penicillin with other commonly used antiseptics

DRUG	CASES TREATED	NO. STERILE AFTER THE TREATMENT	% OF SUCCESS
Camph. P. monochlorophenol	125	93	74.4
Eugenol	143	100	68.9
Formaldehyde-Cresol	43	27	62.7
Penicillin	34	12	35.3

after one treatment. It will be noted that penicillin compared unfavorably with camphorated paramonochlorophenol, eugenol, and formaldehyde-cresol solution. All cases were treated by exactly the same routine except for the different drugs which were sealed in the canal.

The possibility that penicillin-sensitive strains of organisms might become

resistant after exposure to several penicillin treatments was considered. However, there was no evidence in this study that such resistance was produced. In

TABLE IV

Typical cases of penicillin-resistant infections

PATIENT	TOOTH NO.	RADIOLOGY	DRUG USED	BACTERIOLOGY	PENICILLIN SENSITIVITY
D. T.	5	Normal	2- 6-47 Penicillin	*Strep. anhem.*	+
			2-10-47 "	" "	+
			2-12-47 "	" "	+
			2-14-47 "	" "	+
			2-17-47 c.p.m.cl.phe.	" "	+
			2-19-47 "	No Growth	
			2-21-47 "	" "	
L. T.	3	Normal	2-25-47 Penicillin	*Strep. anhem.*	+
			2-28-47 "	" "	+
			3- 7-47 "	" "	+
			3-14-47 "	" "	+
			3-21-47 c.p.m.chl.phe.	" "	
			3-24-47 "	" "	
			3-25-47 Iod. Phe.	No Growth	
			3-28-47 " "	" "	

+ = Penicillin-resistant organism.

TABLE V

Cases of penicillin-sensitive infections

PATIENT	TOOTH NO.	RADIOLOGY	DRUG USED	BACTERIOLOGY	PENICILLIN SENSITIVITY
J. S.	9	Chr. Prolif. Periosteitis	3-3-47 Penicillin	No culture	
			3-6-47 "	*Strep. viridans*	−
			3-8-47 " plus 240,000 u. I. M.	" "	−
			3-10-47 Penicillin	No Growth	
			3-15-47 "	*Strep. viridans*	
			3-17-47 c.p.m.chl.phe.	" "	−
			3-20-47 "	" "	−
			3-22-47 "	No Growth	
			3-27-47 "	" "	
L. P.	4	Normal	2-10-47 Penicillin	*Strep. viridans*	−
			2-12-47 "	" "	−
			2-14-47 "	" "	−
			2-17-47 "	No Growth	
			2-19-47 "	" "	

− = Penicillin-sensitive organism.

only one instance did an organism established as penicillin-sensitive "in vitro" require more than 3 penicillin treatments to obtain the first negative culture.

This strain was exposed to 5 topical penicillin treatments plus 240,000 u. intramuscularly, but was still penicillin-sensitive. (Table V). In short organisms which were penicillin-sensitive at the start of treatment remained sensitive and, conversely, organisms which were penicillin-resistant at the start of treatment remained resistant. Typical cases are shown in Tables IV and V.

CONCLUSIONS

Since the laboratory phase of this study has shown a high incidence of penicillin-resistant organisms to be found in root canal and periapical infections and since clinical results have closely paralleled the laboratory findings, it is concluded that penicillin is not a satisfactory drug for the treatment of such infections. It is obvious that the practicing dentist will have neither the time nor the equipment to determine penicillin-sensitivity and when resistant organisms are encountered much valuable time will be lost if penicillin is used routinely. However, further studies of the newer antibiotics and of possible combinations of penicillin with them, would seem indicated.

The authors are indebted to Bristol Laboratories, Syracuse, New York, for the penicillin used in this study and to Schenley Laboratories, New York, N. Y. for the penicillinase.

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SOME OBSERVATIONS ON THE ASSOCIATION OF THE PRODUCTS OF PROTEIN PUTREFACTION WITH DENTAL CARIES ACTIVITY[1]

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The susceptibility of endemic pellagrins to periodontal disease and their relative immunity to dental caries have been reported from different parts of the world (1, 2, 3, 4). Studies conducted at the Nutrition Clinic of the Hillman Hospital, Birmingham, Alabama, indicate that the lowered incidence of dental caries is not associated with effective amounts of fluorine in the local water supply nor with exceptionally good oral hygiene and restorative dentistry. The diets of these patients are low in proteins and calories but relatively high in fats and refined carbohydrates (5). Kniesner, Mann and Spies (6) found that the saliva of endemic pellagrins and persons with associated vitamin B complex deficiencies contained adequate amounts of the essential nutrients required for the normal growth of *Lactobacillus acidophilus*. In contrast to the reduced caries incidence, endemic pellagra is characterized by the development of an extensive gingivitis and stomatitis which begins at the interdental papillae and progresses rapidly and extensively until the gingivae become tender, painful and often ulcerating (7). This is followed by an invasion of micro-organisms particularly the Vincent's spirochaete, fusiform bacillus, and proteolytic forms which abound in the mouth. The ultimate result is periodontal disease accompanied by gross tissue destruction. The prevalence of periodontal disease in these patients is demonstrated by the work of Mann, Mann and Spies (8) who investigated 160 edentulous patients with long standing records of multiple deficiency disease. They found that periodontal disease was the chief cause of extraction in 105 patients, dental caries in 29 patients, hypersensitivity of the teeth and the advice of physicians in 21 patients and periapical infection in 5 patients.

In the light of these findings, the observations of Lundquist and of Grunert are extremely interesting. Lundquist stated, "In the case of dental caries, it is primarily the degradation of carbohydrate accumulation, which is acid producing, that seems to be at fault; while in the case of periodontal involvements, we are confronted with products of partial protein cleavage, alkaline in effect and toxic in character when related to the adjoining soft tissue" (9). Grunert observed that in periodontal disease the bared necks of the teeth are notably free from decay (10).

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The possible antithetic nature of the processes of dental caries and of gross periodontal disease suggested that the products produced during the breakdown of tissue proteins may in some way affect the development of dental caries. Since indole production has been correlated with the severity of periodontal disease (11), it was decided to determine whether indole and its related compound indole-3-acetic acid (both produced during bacterial decomposition of tryptophane) possessed properties as inhibitors of acid production in saliva. This preliminary report deals with these findings.

MATERIALS AND METHODS

Fifty-one patients were selected for this study from a total of several hundred under observation. The criteria for selection were the presence of 10 or more natural occluding teeth and a history of caries susceptibility as determined from a clinical examination and past results of laboratory tests for dental caries activity (12, 13, 5). Once selected for the study, each patient submitted a single specimen of 50 cc. of paraffin stimulated saliva. The sample was collected in sterile flasks between the hours of 8:00 and 10:00 in the morning. Lactobacillus counts (13), buffer capacity determinations (5), and the chemical test for caries susceptibility of Fosdick, Hansen and Epple (12) were made on each sample. These required 1 cc., 5 cc., and 40 cc. of saliva respectively. The 40 cc. saliva sample alloted for the chemical test was divided into 4 aliquots of 10 cc. each. The first aliquot was tested immediately for soluble calcium. The second was added to a sterile tube containing dextrose and tricalcium phosphate. The third was added to a sterile tube containing dextrose, tricalcium phosphate and 7.5 or 10 mg. of indole, and the fourth was added to a sterile tube containing dextrose, tricalcium phosphate and 10 mg. of indole-3-acetic acid. Saliva samples from 21 and from 30 patients were used to determine the effects of indole and of indole-3-acetic acid respectively. Saliva samples from 18 patients were used to compare the effects of indole and indole-3-acetic acid on different aliquots of the same sample. All aliquots containing dextrose, tricalcium phosphate, indole and indole-3-acetic acid were sealed and submerged in a water bath maintained at 37°C. and agitated constantly for a period of 4 hours. Following the 4 hour period of incubation and agitation, the pH of the sample was determined by means of the glass electrode and the content of soluble calcium was obtained by the method of Fosdick, Hansen, and Epple (12). The difference in the values for soluble calcium before and after incubation gave a measure of the dental caries activity.

To determine the effect of indole, indole-3-acetic acid and dl tryptophane[2] on the growth of the *Lactobacillus acidophilus*, a pure culture of *Lactobacillus acidophilus* (Hadley), isolated from a carious lesion, was secured from the American Type Culture Collection. The organism was carried as a stab culture in a

[2] Tryptophane has been reported by Weisberger and Johnson (14) to be an essential requirement for the maximum growth of an oral strain of *Lactobacillus acidophilus* recovered from a carious lesion.

medium consisting of 3 grams agar, 1 gram dextrose, and 4 grams Difco yeast extract per 200 cc. volume.

The *Lactobacillus acidophilus* inoculum was prepared by transferring from the stab culture to 10 cc. of liquid medium containing the same constituents as the stab medium with the exception of the agar. The culture was incubated for

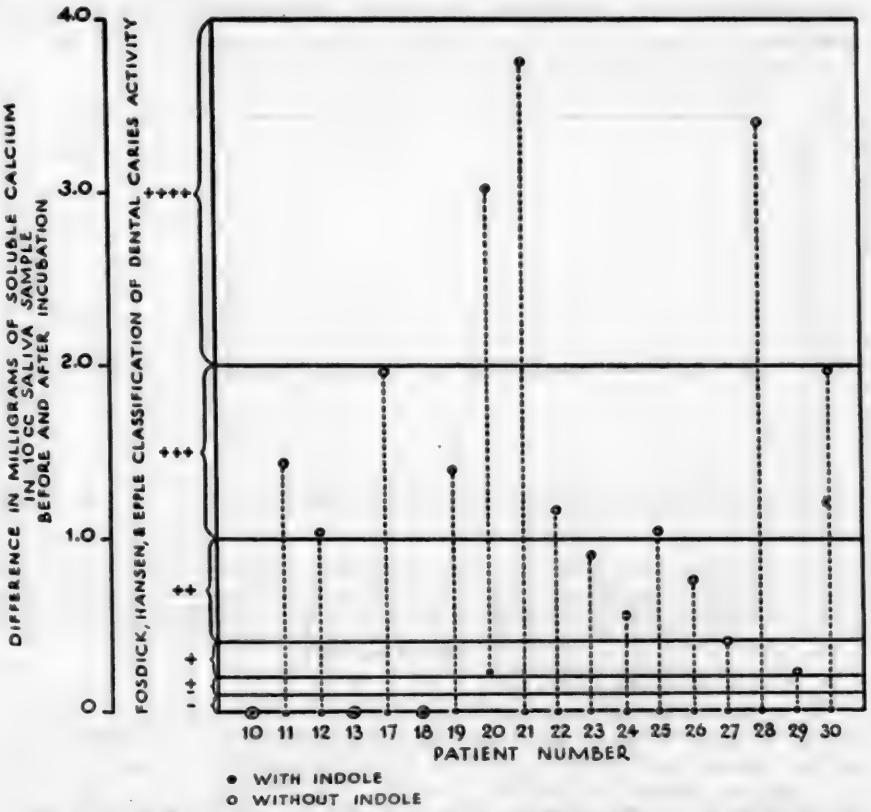

Fig. 1. Effect of the supplement of 10 mgm. indole on acid production in the saliva. Indole completely inhibited acid production in 14 samples and partially inhibited acid production in 1 sample. Three samples were negative for acid production and remained negative following the addition of indole.

24 hours at 37°C. It was then centrifuged and the cells washed in 10 cc. of sterile saline, a procedure which was repeated 4 times. The washed cells were resuspended in 10 cc. of sterile saline, shaken, and 1 drop of this solution was added to 10 cc. of sterile saline. This suspension served as the inoculum. One drop of the inoculum was added to each of 3 series of tubes, set up in triplicate, all of which contained 10 cc. of sterile yeast extract dextrose broth. The first series also contained indole, the second indole-3-acetic acid, and the third dl

tryptophane in the following amounts: 1.0, 1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 6.0 and 7.5 mg. per tube. The tubes and inoculated controls containing no indole, indole-3-acetic acid, or added dl tryptophane and the uninoculated controls containing indole, indole-3-acetic acid, and dl tryptophane in the amounts listed above were shaken and incubated at 37°C. for 72 hours. They were compared for growth and for acid production at the end of 24 hours, 48 hours, and 72 hours. Growth was determined by centrifuging the cultures in Hopkins vaccine tubes and measuring the packed cell volume. Acid production was determined by titration with 0.1N NaOH to the pH of the uninoculated control tubes.

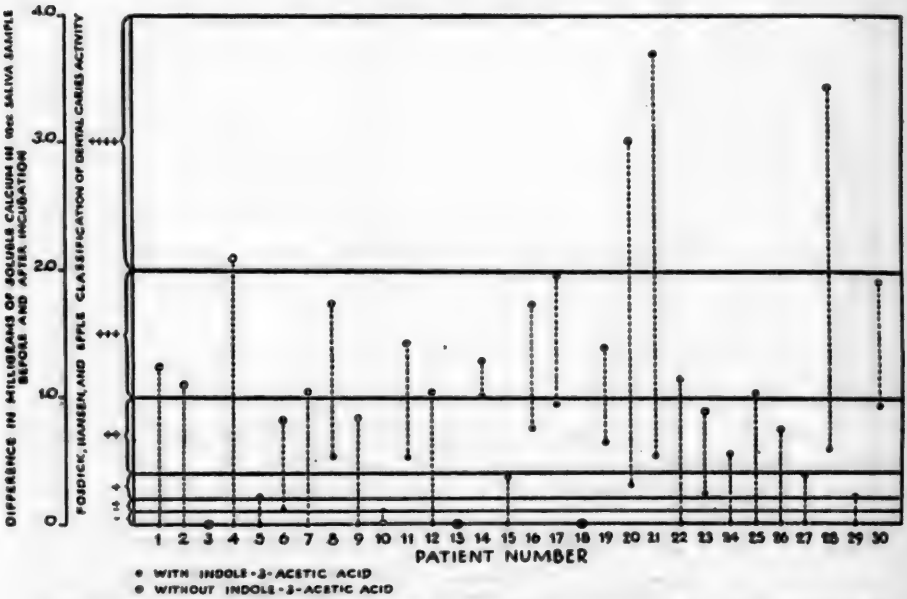
DIFFERENCE IN MILLIGRAMS OF SOLUBLE CALCIUM IN 10cc SALIVA SAMPLE BEFORE AND AFTER INCUBATION
FOSDICK, HANSEN, AND EPPLE CLASSIFICATION OF DENTAL CARIES ACTIVITY
4.0
3.0
2.0
1.0
0
++++
+++
++
+
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
PATIENT NUMBER
WITH INDOLE-3-ACETIC ACID
WITHOUT INDOLE-3-ACETIC ACID

Fig. 2. Effect of the supplement of 10 mgm. indole-3-acetic acid on acid production in saliva. Indole-3-acetic acid completely inhibited acid production in 13 samples and partially inhibited acid production in 13 samples. Three samples were negative for acid production and remained so following the addition of indole-3-acetic acid. There was an increase in the amount of acid production in 1 sample (from patient No. 10) in which indole-3-acetic acid had been added.

In order to determine whether or not dl tryptophane affected the action of indole and indole-3-acetic acid, a second group of 3 series of tubes was set up. Each tube contained 10 cc. of yeast extract dextrose broth and 1 drop of inoculum. In addition, all the tubes in the first series contained 7.5 mg. of dl tryptophane and varying amounts of indole. Those in the second serie scontained 7.5 mg. of indole and varying amounts of dl tryptophane. Those in the third series contained 7.5 mg. of indole-3-acetic acid and varying amounts of dl tryptophane. The tubes were shaken, incubated at 37°C. for 72 hours and read in the same manner as described above.

OBSERVATIONS

Fig. 1 contains a summary of the findings which demonstrate the effect of indole on acid production in 10 cc. samples of saliva from 18 different patients. Of the 18 samples to which 10 mg. quantities of indole were added, 14 showed a

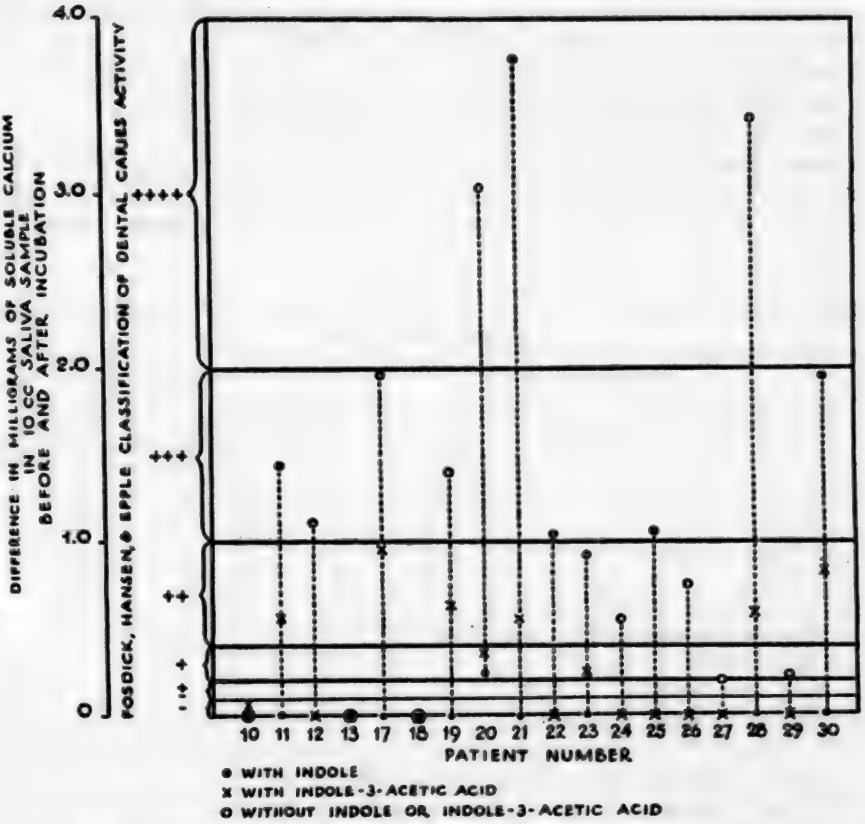

Fig. 3. Comparative effect of supplements of 10 mgm. indole and 10 mgm. indole-3-acetic acid on aliquots of the same saliva sample. Indole and indole-3-acetic acid both interfered with acid production in different aliquots of the same saliva sample in 16 patients. Two samples were negative and remained so following the addition of indole or indole-3-acetic acid. Indole produced a much more pronounced effect than did indole-3-acetic acid when used in the same amounts by weight.

complete, and 1 a partial inhibition of acid production. Three samples were negative for acid production and remained negative following the addition of indole. (In 3 samples to which 7.5 mg. was added, acid production was inhibited completely in one and partially in the two others.)

Fig. 2 shows the results of the addition of 10 mg. quantities of indole-3-acetic acid to 10 cc. samples of saliva from 30 different patients. Indole-3-acetic acid

exerted an inhibitory effect in 26 of the 30 samples. The effect was complete in 13, partial in 13 and a slight increase in the amount of acid produced was noted in 1 sample. Three were negative and remained so following the addition of indole-3-acetic acid.

Fig. 3 and Table I demonstrate the relative effects of indole and indole-3-acetic acid on acid production in the 10 cc. aliquots of the same saliva sample in the 18 instances in which they were compared. It will be noted that, while both compounds exerted an inhibitory effect in all instances, indole was more effective than indole-3-acetic acid when used in the same amounts by weight.

The effect of indole, indole-3-acetic acid, and dl tryptophane in quantities ranging from 1 to 7.5 mg. per 10 cc. yeast extract dextrose broth on the growth and acid production of the *Lactobacillus acidophilus* (Hadley) is shown in Table II. It will be noted that at the end of 24 hours there was no growth or acid

TABLE I

Effect of indole and indole-3-acetic acid on acid production when added to different aliquots of same saliva sample

UNTREATED SALIVA‡			TREATED SALIVA‡	
Caries Activity*	No. of Samples	Average No. Mg. Ca.	Average No. Mg. Ca. in saliva + indole	Average No. Mg. Ca. in saliva + indole-3-acetic acid
−	3	0.00	0.00	0.00
+	1	0.22	0.00	0.00
++	4	0.66	0.00	0.06
+++	7	1.33	0.01	0.45
++++	3	3.39	0.10	0.47

* Fosdick, Hansen, Epple Classification.

‡ 10 cc. sample.

production in those tubes in which indole was added in quantities ranging from 2.5 to 7.5 mg. This effect was confined to the tubes containing 4.0 to 7.5 mg. at the end of 48 hours, and to the tubes containing 6.0 and 7.5 mg. at the end of 72 hours. A partial inhibitory effect was noted in those tubes containing concentrations ranging from 3.0 to 5.0 mg. at the end of 72 hours. The degree of inhibition was related, therefore, to the period of incubation and the concentration of indole.

Indole-3-acetic acid inhibited growth and acid production in concentrations from 4.0 to 7.5 mg. during the first 24 hours. A diminution of the inhibitory action occurred during the next 48 hours. At the end of seventy-two hours a partial inhibition of growth and acid production was confined to those tubes containing concentrations of 5.0 mg. and above. The degree of inhibition was again related to the concentration of indole-3-acetic acid and the period of incubation. The effect, however, was less pronounced than that exerted by indole, when used in the same amount by weight.

When used alone, dl tryptophane did not affect the growth and acid production of this organism in any of the concentrations employed.

The effect of the addition of varying amounts of dl tryptophane on the action of indole and indole-3-acetic acid is indicated in Table III. When dl tryptophane was added to the series of tubes containing 10 cc. yeast extract dextrose broth,

TABLE II

Effect of indole, indole-3-acetic acid, and dl tryptophane on the growth and acid production of the Lactobacillus acidophilus (Hadley)

TUBE	GROWTH (PACKED CELL VOLUME)*			ACID PRODUCTION (CC. 0.1N NaOH)		
	24 hrs.	48 hrs.	72 hrs.	24 hrs.	48 hrs.	72 hrs.
Control	±	+++	+++	0.20	4.80	4.80
Indole:						
1.0 mg.	±	+++	+++	0.10	4.50	4.90
1.5 mg.	±	+++	+++	0.10	4.00	4.85
2.0 mg.	+	+++	+++	0.05	3.50	4.85
2.5 mg.	−	+++	+++	0.00	2.40	4.50
3.0 mg.	−	+++	+++	0.00	1.90	3.10
4.0 mg.	−	−	++	0.00	0.00	2.30
5.0 mg.	−	−	+	0.00	0.00	0.90
6.0 mg.	−	−	−	0.00	0.00	0.00
7.5 mg.	−	−	−	0.00	0.00	0.00
Indole-3-Acetic Acid:						
1.0 mg.	±	+++	+++	0.10	4.70	4.90
1.5 mg.	±	+++	+++	0.10	4.10	4.85
2.0 mg.	±	+++	+++	0.10	4.00	4.80
2.5 mg.	±	+++	+++	0.05	3.85	4.80
3.0 mg.	−	+++	+++	0.05	3.45	4.65
4.0 mg.	−	+++	+++	0.00	2.10	4.60
5.0 mg.	−	++	++	0.00	1.80	3.85
6.0 mg.	−	++	++	0.00	1.50	3.70
7.5 mg.	−	+	++	0.00	1.25	2.20
dl Tryptophane:						
1.0 mg.	±	+++	+++	0.15	4.70	4.80
1.5 mg.	±	+++	+++	0.25	4.60	4.75
2.0 mg.	+	+++	+++	0.50	4.25	4.85
2.5 mg.	++	+++	+++	1.07	4.65	4.90
3.0 mg.	++	+++	+++	0.72	4.20	4.90
4.0 mg.	±	+++	+++	0.43	3.45	4.90
5.0 mg.	+	+++	+++	0.28	3.35	4.75
6.0 mg.	+	+++	+++	0.50	3.35	4.75
7.5 mg.	±	+++	+++	0.80	3.50	4.90

* 0.0–0.1 cc. −
0.1–0.25 cc. ±
0.25–0.5 cc. +
0.5–1.0 cc. ++
1.0–2.0 cc. +++

1 drop of the inoculum, and 7.5 mg. indole, in amounts ranging from 1.0 to 7,500.0 mg., growth and acid production were completely inhibited in all tubes. When indole was added to the series of tubes containing 10 cc. yeast extract

dextrose broth, 1 drop of inoculum, and 7.5 mg. of dl tryptophane, in amounts ranging from 1.0 to 7.5 mg., growth and acid production were partially inhibited in those tubes containing from 1.5 to 5.0 mg. indole and were completely inhibited in the tubes containing 6.0 mg. and above. When dl tryptophane was added to a series of tubes containing 10 cc. yeast extract dextrose broth, 1 drop of inoculum, and 7.5 mg. indole-3-acetic acid, in amounts ranging from 1.0 to 7.5 mg., growth and acid production were partially inhibited in all concentrations.

TABLE III

Effect of the addition of dl tryptophane on the action of indole and indole-3-acetic acid

TUBE		GROWTH (72 HRS.) (PACKED CELL VOLUME)	ACID PRODUCTION (72 HRS.) (CC. 0.1N NaOH)
Indole (mg.) + dl Tryptophane (mg.)			
7.5	0.0	−	0.00
7.5	1.0	−	0.00
7.5	1.5	−	0.00
7.5	2.0	−	0.00
7.5	2.5	−	0.00
7.5	3.0	−	0.00
7.5	4.0	−	0.00
7.5	5.0	−	0.00
7.5	6.0	−	0.00
7.5	7.5	−	0.00
7.5	75.0	−	0.00
7.5	750.0	−	0.00
7.5	7500.0	−	0.00
dl Tryptophane (mg.) + Indole (mg.)			
7.5	0.0	+++	4.90
7.5	1.0	+++	4.60
7.5	1.5	++	2.60
7.5	2.0	++	2.35
7.5	2.5	++	2.40
7.5	3.0	++	2.00
7.5	4.0	+	0.90
7.5	5.0	±	0.40
7.5	6.0	−	0.00
7.5	7.5	−	0.00
Indole-3-Acetic Acid (mg.) + dl Tryptophane (mg.)			
7.5	0.0	++	2.30
7.5	1.0	++	2.15
7.5	1.5	++	2.25
7.5	2.0	++	2.20
7.5	2.5	++	2.15
7.5	3.0	++	2.30
7.5	4.0	++	2.25
7.5	5.0	++	2.30
7.5	6.0	++	2.35
7.5	7.5	++	2.30

DISCUSSION

The findings reveal that indole and indole-3-acetic acid, when present in adequate amounts, are capable of interfering with acid production in saliva and with the growth and acid production of a pure strain of *Lactobacillus acidophilus* recovered from a carious lesion. The effect of indole appears to be enhanced somewhat by the presence of dl tryptophane in the medium. This is of interest in the light of a report by Turner and Crowell (15) who found that an indirect correlation existed between the amount of tryptophane or similar indole containing molecules in the saliva and the degree of dental caries.

The production of ammonia, indole, indole-3-acetic acid, skatole, phenol, cresol, cadaverine, putrescine and mercaptans from the bacterial breakdown of tissue protein is well established (16, 17). Kesel, O'Donnell, Kirch and Wach (18) have shown that ammonia can be used therapeutically to prevent dental caries. Curran, Rogers and Whittier (19) reported that cultures of the *Lactobacillus acidophilus* obtained from dental caries are, for the most part, inhibited by relatively dilute solutions of phenol and indole.

The action of indole-3-acetic acid, indole and skatole[3] together with the previously demonstrated inhibitory power of some of the other putrefactive products of protein breakdown such as ammonia, phenol and possibly cresol is, therefore, of import as it may offer a partial explanation for the decreased incidence of dental caries associated with extensive periodontal breakdown in endemic pellagrins and patients with associated vitamin B complex deficiencies.[4]

SUMMARY AND CONCLUSIONS

1. Indole (7.5 or 10 mg.) or indole-3-acetic acid (10 mg.) partially or completely inhibited acid production in vitro in 10 cc. samples of saliva in 50 of the 51 patients studied.

2. Indole inhibited the growth and acid production of the *Lactobacillus acidophilus* (Hadley) in yeast extract dextrose broth when added in a concentration of 6.0 mg. per 10 cc. of broth. When added in concentrations ranging from 2.5 to 5.0 mg. per 10 cc. of broth, it exerted a partial inhibitory effect on the growth and acid production of this organism.

3. Indole-3-acetic acid partially inhibited the growth and acid production of the *Lactobacillus acidophilus* (Hadley) in yeast extract dextrose broth when added in concentrations ranging from 5.0 to 7.5 mg. per 10 cc. of broth.

4. dl Tryptophane did not inhibit the growth and acid production of *Lactobacillus acidophilus* (Hadley) in any of the concentrations employed. In the

[3] Since this paper was written, we have added skatole to the saliva of 10 patients in amounts varying from 2.0 to 7.5 mg. per 10 cc. saliva. In every instance acid production was markedly reduced. These results will be published in their entirety in a subsequent communication.

[4] Indole-3-acetic acid is present in corn in amounts varying from 20 to 100 mg. per kgm. This is of some interest as endemic pellagra is often associated with the consumption of corn or corn products (20) (21).

presence of dl tryptophane, however, the inhibitory effect of indole was increased.

5. Indole and indole-3-acetic acid, products of the bacterial decomposition of tissue proteins, in dilute solutions did not support the maximum growth of a strain of the oral *Lactobacillus acidophilus* recovered from a carious lesion. This lends support to our working hypothesis that the products of protein putrefaction may to some extent be responsible for the decreased incidence of dental caries accompanied by extensive periodontal disease which is often seen in endemic pellagrins and persons with chronic vitamin B complex deficiencies.

We are indebted to Miss Thelma Skinner for the caries activity determinations and to Miss Elizabeth Scholz and Miss Emily Williams for their aid in the bacteriological determinations.

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ADAPTABILITY OF THE PERIODONTAL MEMBRANE

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There are recorded in the literature many examples of the adaptability of the periodontal membrane (1–6). The diagrams in *fig. 1* are representatives of a variety of alterations of the normal attachment apparatus. Bone is represented in solid black, cementum as white blocks, and periodontal fibers as black lines.

In *fig. 1*, diagram A, there is shown a tooth with alveolar bone in the pulp chamber, together with an attachment apparatus of periodontal fibers attached to cementum on the walls of the pulp chamber. Such an adaptation was described in a fractured tooth (2) and in a retained deciduous tooth (3). Diagram B of *fig. 1* shows a root through which there was a horizontal opening caused by resorption. In this resorbed opening there was an alveolar process with an attachment apparatus (3). Diagram C of *fig. 1* shows an example of resorption, variously described as internal or external resorption. In the resorbed area, in some instances involving the pulp and in other instances with no pulpal involvement, there is shown alveolar bone with an attachment apparatus (3–4). Diagram D of *fig. 1* shows a fractured tooth with alveolar bone in the separation space, with an attachment apparatus (1). Diagram E of *fig. 1* shows a tear of the cementum, with an attachment apparatus of cementum on the root surface: periodontal fibers, cementum, periodontal fibers, alveolar bone (5–6). In this presentation another variability, not previously reported, is shown. Diagram F of *fig. 1* shows a tear of the cementum with an attachment apparatus of cementum on the root surface: periodontal fibers, new bone, periodontal fibers, cementum, periodontal fibers, alveolar bone.

Figs. 2 to 6, inclusive, are from human material. There were minor cross fractures involving other teeth in the same jaw, indicating that all of these teeth were subjected to horizontal stresses.

Fig. 2 is from the mesial surface of the root of the mandibular right first incisor. *Fig. 3* is from the distal surface of the root of the mandibular right second incisor. *Fig. 4* is from the distal surface of the maxillary right second incisor root. *Fig. 5* is from the distal surface of the mandibular left second premolar root. *Fig. 6* is a higher magnification of the new bone, B; old cementum, OC, and the torn cementum TC.

In all the specimens shown in figs. 2 to 6, inclusive, there existed a wide space

[1] Presented at the 25th General Meeting of the International Association for Dental Research, Chicago, Ill., June 21–22, 1947. (*J. D. Res.* **26**: 421, 1947.) Received for publication August 1, 1947.

between the torn cementum fragments and the old cementum. New bone with new periodontal fibers was formed in this space. This peculiar repair phenomenon was in response to functional stimuli which demanded an attachment apparatus to withstand the masticatory stresses.

In a previous paper (3) it was stated that "where the space was wide, bone with new periodontal fibers . . . . will result." It seems that after each tooth has been completely calcified, and is in occlusion, an attachment apparatus capable

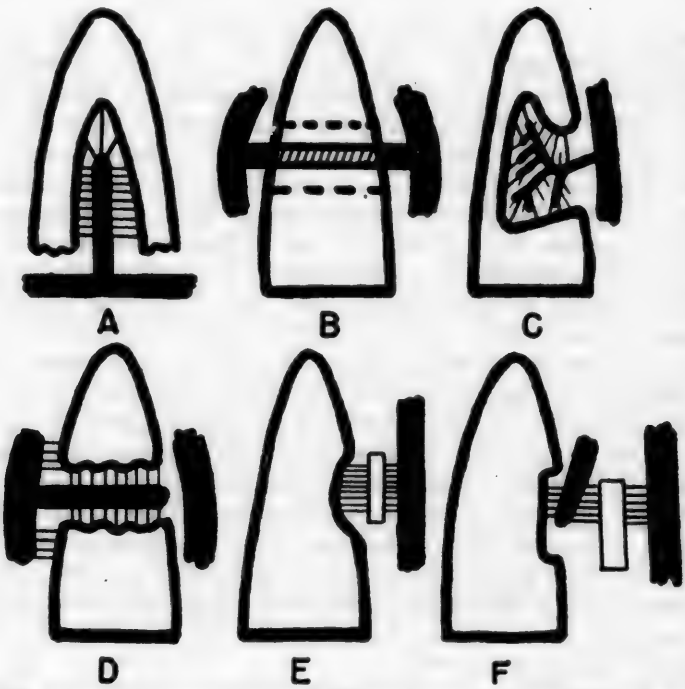

Fig. 1. **Diagrammatic representation of different types of adaptability of the attachment apparatus.**

of supporting that tooth is established. When additional stresses are present, the cementum will thicken in addition to a widening of the periodontal membrane. Following injuries, such as fractures, tears in the cementum, root resection and resorbed roots of teeth that are retained and in function, there will be created varying kinds of an attachment apparatus in response to functional stimuli. These adaptations vary from a simple hypercementosis which increases the surface area of the root to enable enough fibers to become re-attached to supplant those that have been lost, to a new alveolar bone with an abnormal periodontal fiber arrangement and attachment.

Fig. 7, which is from the root end of a maxillary canine, seems to confirm the

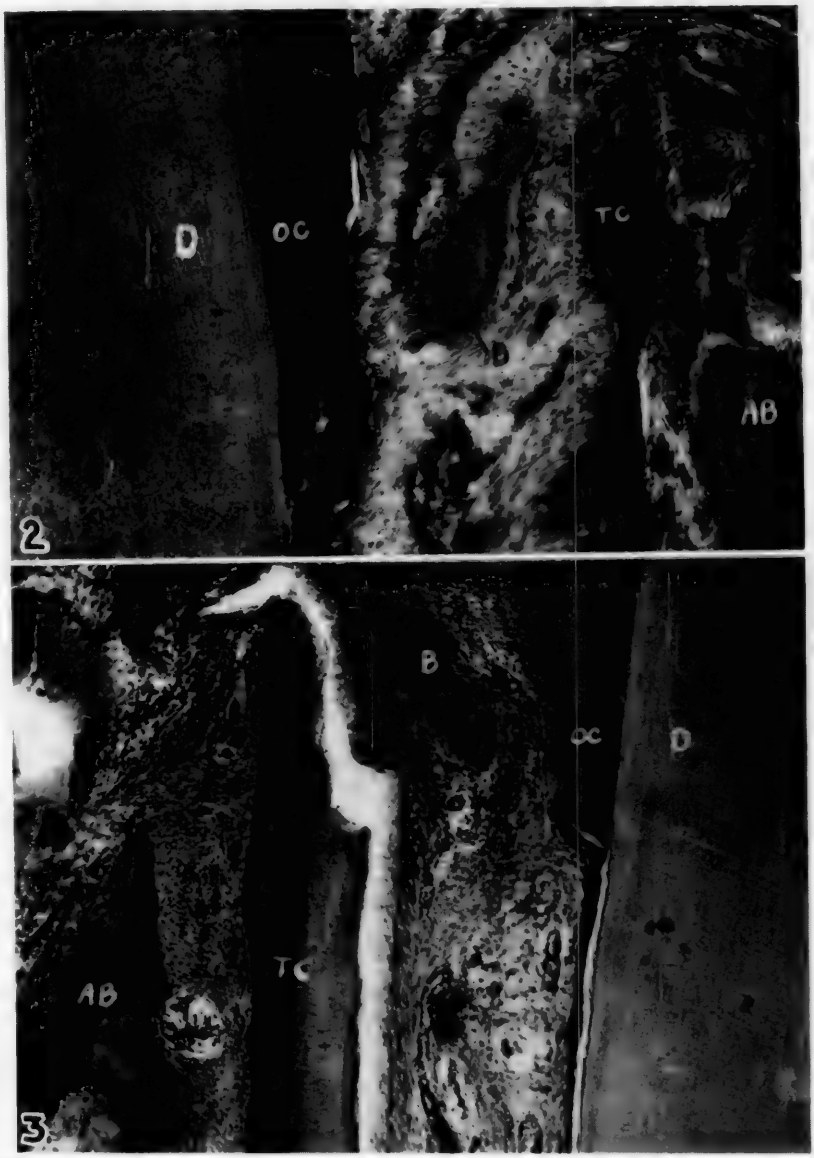

Fig. 2. (Upper) Tear of the cementum from the mesial surface of a mandibular first incisor. D, dentin; OC, old cementum, TC, torn cementum. B, new bone; AB, alveolar bone.

Fig. 3. (Lower) Tear of the cementum from the distal surface of mandibular second incisor. D, dentin; OC, old cementum; TC, torn cementum; B, new bone; AB, alveolar bone.

Fig. 4. (Upper left) Tear of cementum from the distal surface of a maxillary second incisor. D, dentin; OC, old cementum; TC, torn cementum; B, new bone, AB, alveolar bone.

Fig. 5. (Upper right) Tear of cementum from the distal surface of a mandibular second premolar. D, dentin; OC, old cementum; B, new bone; TC, torn cementum, AB, alveolar bone.

Fig. 6. (Lower left) Higher magnification of *fig. 5*. OC, old cementum; B, new bone; TC, torn cementum.

Fig. 7. (Lower right) Root end of a maxillary canine. B, bone in the apical foramen.

conclusion that alveolar bone will from in a wide space. The tendency of the periodontal membrane is to maintain a certain width.

It might be reasoned that the new bone seen in *figs. 2* to *6*, inclusive, is an indication of a bony callus in the repair process. However, the facts that the new bone occupies a central position in the space and that the periodontal fibers are well organized would tend to negate this interpretation. Callus formation in repair appears different. *Fig. 8* shows callus formation in a fracture of a mandibular first incisor. The callus, C, is a hyaline, acidophil material probably cementoid, and is attached to the fractured segments. *Fig. 9* shows a tear in the cementum of a maxillary first incisor. Here the torn cementum fragment is partly attached to the old cementum with a similar cementoid material and cementum.

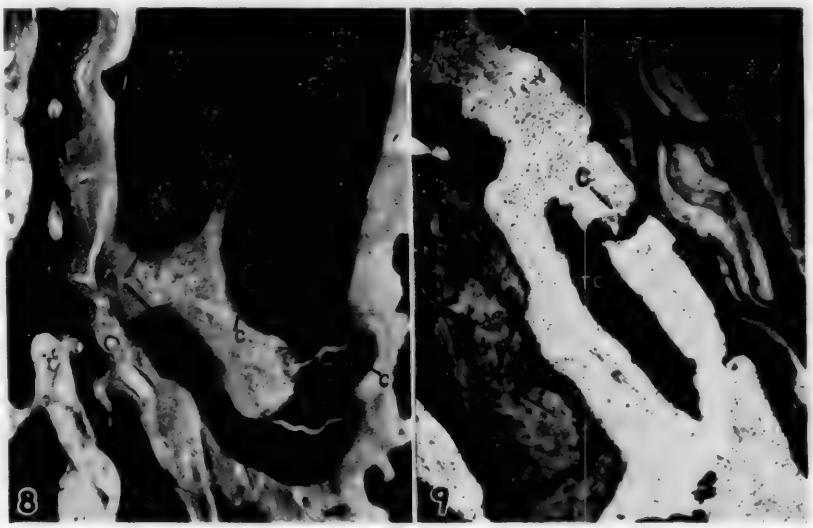

Fig. 8. (Left) Fracture of the root of a mandibular first incisor. C, callus formation.
Fig. 9. (Right) Tear of cementum from the distal surface of a maxillary first incisor. TC, torn cementum; C, callus formation.

CONCLUSION

Because of the exhibited tendencies of the many varieties of adaptability of the periodontal membrane in repair processes, teeth being treated for periodontal disease should be immediately subjected to functional stresses.

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TRANSPARENCY AND LIGHT SCATTERING OF DENTAL HARD TISSUES[1]

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Some of the earliest dental investigators had an insight into the optical basis for the formation of translucent dentin from normal dentin. Tomes (1) in 1848 and Czermak (2) in 1850 held the opinion that the various types of translucency arose because of an "equalization of the normally different indices of refraction of the tubules and of the calcified dentine matrix" (2). Furrer (3) and Fish (4) attributed the transparency to an increase in the optical homogeneity of the dentin.

Kronfeld (5) compared dentin to a bundle of glass tubes, and the development of transparency to the change in appearance that takes place when the bundle is immersed in water. This analogy may be used to explain the chief optical behavior of normal dentin. A beam of light passing through a bundle of glass tubes meets with a great number of glass surfaces, at which the light passes from air to glass or vice versa. At each of these surfaces part of the beam is refracted and reflected from its original direction, until finally the directional characteristics of the light are nearly lost. The light is almost completely diffused. A similar quantity of light leaves the bundle in all directions, just as if the light source were within the center rather than outside of the bundle. Only a small fraction of light passes out in the same direction as that of the original beam.

Miller (6) recognized this type of behavior as being responsible for the opacity of normal dentin, and Noyes held it to be the basis for dentin's characteristic luster (7). Studies from this laboratory on light transmission by different thicknesses of dentin have shown that this tissue has a light scattering power higher than opal glass (8).

Transparency of dentin may be produced by changes which decrease the size or number of refracting surfaces within the dentin or the amount of refraction per surface. Probably most of the refraction is caused by the tubules. The crystals of mineral are only 0.1 microns in length (9). This is less than the wave length of light, and refraction could not take place from their surfaces. The dentinal

[1] This work was supported by a grant from the Carnegie Corporation of New York, and was presented in part at the Chicago Midwinter Dental Society Meeting, February, 1939. The data are taken from the thesis submitted by the senior author to the Division of Graduate Studies of the University of Rochester in partial fulfillment for the Degree of Doctor of Philosophy. Received for publication September 16, 1947.

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fibrils are 0.3 microns in diameter (10) and are partially calcified, which makes it probable that little refraction arises from their surfaces.

If the tubules are obliterated by the calcific deposits, or are decreased in size, there should be less light scattering and a greater transparency. Microscopic observations concerning the tubular size (4, 6, 11, 12) and studies on the penetration of dyes (3, 6, 13, 14) have indicated that the tubules of transparent dentin are smaller than those in normal dentin. Observations on the radiopacity of translucent and normal dentin (7, 15, 16, 17, 18) suggest that calcific material has been deposited within the tubules of transparent dentin. The transparency is associated with a decrease in light scattering as indicated by a lessened depolarization of light (19), and by a fall of over 90% in the scattering coefficient (8).

There is a simple test of this explanation for translucency which has never been applied. The amount of refraction by the tubules can be changed by replacing their contents with a liquid having a different refractive index. Certain liquids used in histological preparation are known to produce a clearing or greater transparency of dentin. There is no information whether the transparency so produced will obey predictions from the optical laws concerned with the passage of light from one medium to another. Refraction and reflection increase as the difference between the refractive indices of the two media becomes greater. When tubules are filled with tissue fluid, the refractive index of their liquid contents is 1.33+. If tissue fluid is replaced by a liquid having a higher refractive index, translucency of dentin should be increased. It should reach a maximum when the liquid within the tubules has the same index as the dentin matrix, i.e., 1.56. Under these conditions there is the least refractive difference between matrix and tubular contents. Light scattering from tubular surfaces should be minimal and, therefore, the light which passes through undeflected will be maximal. When the liquid within the tubules is further increased in refractive power, the difference in index becomes greater and translucency of dentin should be less. The same pattern of events should occur with dentin that has already become transparent in vivo, except that transparency should be modified to a lesser extent by immersion liquid.

Our experiments were undertaken primarily in order to test these hypotheses. In addition we have collected comparative data on the transparency of different areas of tooth sections, and compared the transparency with the water and ash percentages of these zones.

PROCEDURE

Fresh teeth were obtained daily from the extraction clinic of Strong Memorial Hospital, placed under tap water, and preserved in a refrigerator. Longitudinal sections about 1 mm. thick were cut with a slotting engine, and ground under water with aloxite to 2 ranges of thickness, 0.05 to 0.25 mm., and 0.50 to 0.80 mm.

The transparency of a small area of a slab was measured on a microscope equipped with a 4 mm. objective and a photoelectric cell fastened to a 5× ocular

(8). The light passing through various areas was compared with that which passed when the section was pushed aside. Percentage transmission of normal dentin was obtained from crown dentin which had undergone no microscopic modification. Carious dentin values were obtained from carious areas which had a yellow or brown discoloration, and the translucent zones sometimes seen beneath the carious dentin were called caries-transparent dentin. Portions of the root showing marked translucency were called root transparent dentin, and the yellowish dentin cones sometimes appearing between the pulp and an attrited occlusal surface were designated attrition cones (20).

The effect of immersion liquid on light transmission was studied on 4 sections ranging from 0.08 to 0.15 mm. thick. Each section was immersed successively in water (n_D − 1.33), dihydroxyethyl ether (cellosolve) (n_D − 1.45), a mixture of petrolatum and alpha-chlornaphthalene with a refractive index of 1.56, and pure alpha-chlornaphthalene with a refractive index of 1.63. The light transmission was determined in each liquid for zones of enamel, secondary cementum and normal, caries-transparent, carious and transparent root dentin.

Samples of various zones were obtained by grinding with a dental bur under water. The particles were separated from the water by suction on a micro-Nebauer crucible. The moist particles were transferred to a tared procelain microboat and placed in contact with moving air at 95% relative humidity for 6 hours in order to remove excess water held by capillarity. The microboat was weighed on a microbalance, then the sample dried 2 hours in vacuo at 100°C. The difference has been called "moisture." The basis for the method is discussed in detail elsewhere (21, pages 126–128, 147–154, 207–208). It is entirely empirical but gives consistent values that fall within the range established by other procedures.

The dry powder was converted to a carbonate-free ash by adding a drop of nitric acid to the particles and igniting the boat at 650° C for 10 minutes. The ash percentage was calculated on the dry weight.

RESULTS

The effect of immersion liquid on transparency

The results given in *Fig. 1A* for normal dentin agree with predictions from the theory. The transparency of normal dentin was 41% when the tubules were filled with water, and it became 87% when dentin was immersed in a liquid having a refractive index of 1.56. When the tubules contained a liquid having an index of 1.63, the transparency was slightly less.

Transparent dentin under caries exhibited a similar behavior except that transparency in water was greater, and the maximum transparency was lower. Pigmented carious dentin likewise reached a maximum, but the maximum was considerably lower because of the light absorbed by the pigment.

Transparent root dentin and cementum (*Fig. 1B*) were affected only slightly by the change in immersion liquid, and enamel decreased in transparency as the refractive index of the liquid increased.

The effect which vacuum drying has upon transparency was also studied (Table I) in order to determine how much effect would be exerted by replacement of tubular tissue fluid by air ($n_D = 1.00$). The sections were not the same as those employed for tests given in *fig. 1*, and the average transparencies of the wet sections were different, but for a study of the effect of drying the comparison should be satisfactory. All zones were less transparent after drying. Pig-

TABLE I

Effect of drying on transparency of tooth sections (0.05–0.25 mm. thick)

	PERCENTAGE TRANSMISSION OF LIGHT	
	Wet	Vacuum dried
Dentin		
Normal	55	38
Brown Carious	38	32
Caries Transparent	66	52
Root Transparent	66	60
Cementum	65	49
Enamel	64	49

TABLE II

Transparency of dental hard tissues

	PER CENT OF INCIDENT LIGHT			
	0.05–0.25 mm. thickness		0.50–0.80 mm. thickness	
	Av.	Av. dev. from av.	Av.	Av. dev. from Av.
Dentin				
Normal	55 (23)	±9	20 (18)	±4
Carious	45 (16)	±17	11 (14)	±11
Caries Transparent	66 (13)	±9	34 (20)	±10
Root Transparent	74 (21)	±6	63 (7)	±9
Attrition Cones	51 (7)	±7	20 (5)	±9
Secondary	70 (4)	±7	60 (4)	±2
Cementum	71 (21)	±6	50 (3)	±6
Enamel				
Normal	67 (19)	±6	41 (5)	±10
Carious	37 (5)	±7	13 (6)	±4

Figures in parentheses indicate the number of determinations averaged.

mented carious dentin and root transparent dentin were least affected, and the other zones studied were diminished in transparency to about the same extent.

Average transparency and its relation to moisture and ash percentage

The data on average transparency of different zones of tooth slabs are presented in Table I. With the thinner sections the range in transparency of different zones was from 37 to 74%. With the thicker sections, the range was from 11 to 60%, indicating that the contrast is considerably greater.

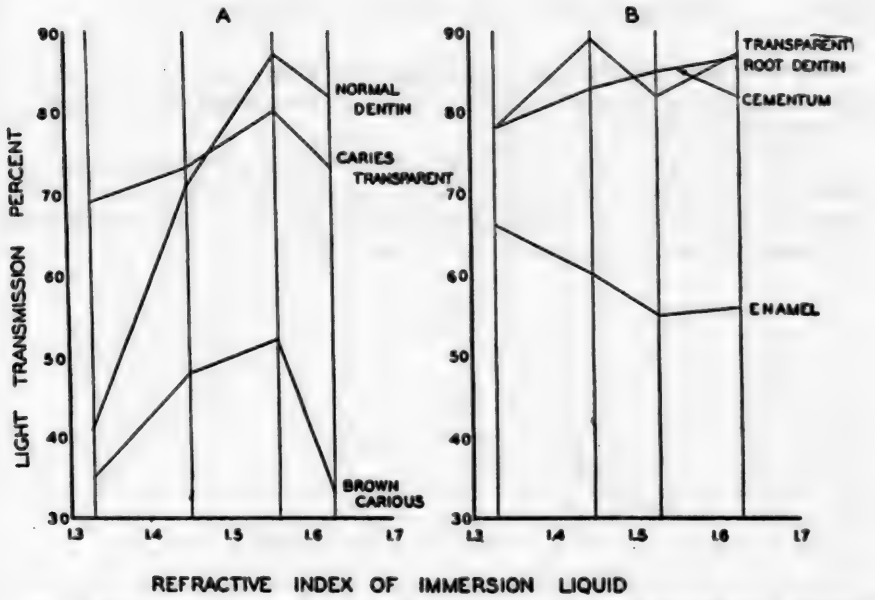

Fig. 1. Effect of immersion liquid on the transparency of dental hard tissues. Normal dentin is most affected and transparency is maximal when the refractive index of the liquid is 1.56.

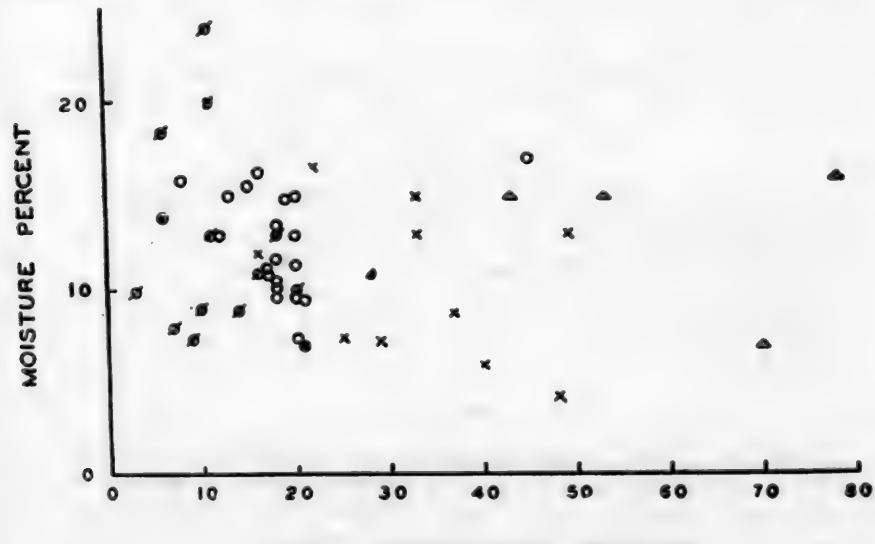

Fig. 2. A comparison of transparency and moisture percentage for different areas of dentin. There is no correlation between the 2 measurements.

Brown, carious dentin..... ⌀
Transparent dentin next to carious dentin..... ×
Opaque dentin next to carious dentin..... ⊗
Transparent root dentin..... △
Normal dentin..... ○

The most transparent classes of dental hard tissue were transparent root dentin, secondary dentin and cementum, and the least transparent were carious enamel and dentin.

Figs. 2 and *3* present a comparison between the light transmission and the moisture and inorganic percentages. The location of the points in these figures indicates that there is no correlation between percentage of light transmission and either the moisture or the inorganic percentage.

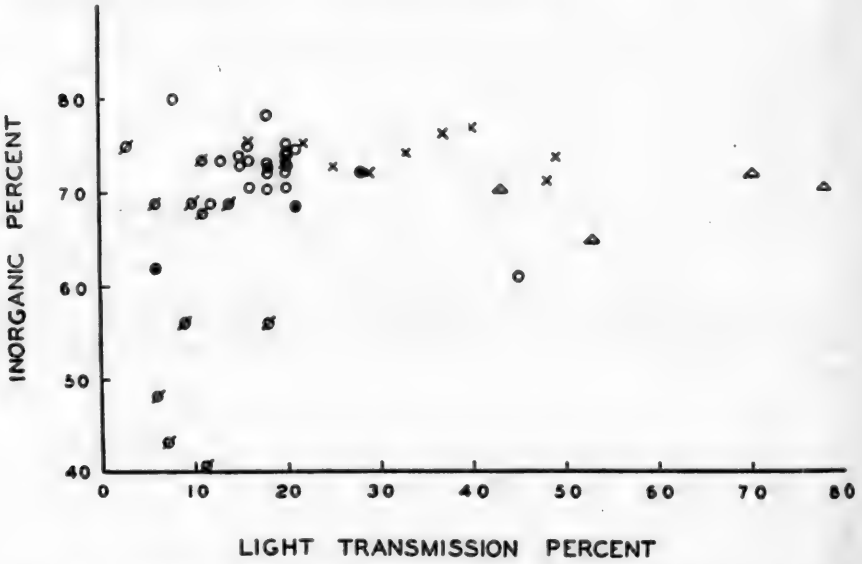

Fig. 3. A comparison of inorganic percentage and transparency for different areas of dentin. There is no correlation between the measurements.

Brown, carious dentin..... ⌀
Transparent dentin next to carious dentin..... ×
Opaque dentin next to carious dentin..... ⊗
Transparent root dentin..... △
Normal dentin..... ○

DISCUSSION

At least four-fifths of the opacity of normal dentin is due to refractive effects, for that fraction of the opacity is lost when normal dentin is immersed in a liquid of appropriate refractive index. Dentin which has become transparent in vivo is less affected by immersion liquids than normal dentin, and its maximum transparency is similar to the maximum transparency that can be produced in normal dentin.

These findings support the hypothesis that normal dentin becomes transparent in vivo by deposition of a matrix-like calcification in the tubules. The effect of such change on chemical composition will depend upon the nature of tubular

contents. If the tubules are normally filled with tissue fluid, replacement of the tissue fluid by a deposit having the composition of cementum should decrease the moisture percentage by 7% and the inorganic percentage by only 0.4%. This calculation is based on the assumption that the tubular volume amounts to about 14% (12, page 608) and that the inorganic percentage of cementum is 73% (21, p. 54 and 92). The percentage of mineral salts per unit volume would be increased by nearly 14%, but the percentage per unit weight would be only slightly changed, and the change would be downward.

The study by Simon and Armstrong (22) involved a comparison of samples of root dentin having slight and marked translucency. The ash percentage was calculated on a weight basis and the more translucent dentin had 0.32% less ash. Our results on translucent crown dentin adjacent to caries permit us to make comparisons with normal crown dentin of the same teeth. The translucent zones had on the average 0.4% less inorganic material. This is in agreement with the data of Simon and Armstrong, but our interpretations of the findings are different. It is our belief that transparency arises because the tubules become partially filled with a matrix-like deposit, rather than because the matrix becomes slightly decalcified, as Simon and Armstrong supposed.

The behavior of enamel in immersion liquids does not agree with the theory which applies to dentin. The refractive index of enamel is 1.615–1.625 (23). Yet the maximum transparency of enamel occurs in water, and successive treatments with immersion liquids decrease it by about 10%. A lower transparency was also produced by drying (Table I). Perhaps these observations are related, and the chief effect of immersion liquids is dehydration. If the immersion liquids do not completely penetrate and replace the water that is lost, the theory for dentin would not be applicable.

SUMMARY

Measurements were made of the transparency of different areas of moist tooth sections, and the changes in transparency were observed after drying and after immersing the sections in liquids with known refractive indices. Average values and normal variations are reported for light transmission by several different areas of dental hard tissues. The transparencies of dentin areas were not correlated with the moisture or ash percentages of the areas. Transparency of normal dentin was dependent upon the refractive index of the media filling the tubules, and was greatest when the refractive indices of tubules and matrix were the same; dentin modifications which had become transparent in the mouth were similarly affected but to a lesser degree. The findings suggest that dentin becomes transparent in vivo because of calcific deposits within the tubules, and that the deposits resemble cementum in their degree of calcification.

The authors are grateful for the advice and encouragement offered by Dr. H. C. Hodge throughout the work.

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INTERNATIONAL ASSOCIATION FOR DENTAL RESEARCH

Proceedings of the Twenty-fifth General Meeting[1]
Drake Hotel, Chicago, Illinois

June 21 and 22, 1947

Compiled by Hamilton B. G. Robinson, Editor[2]

Ohio State University, Columbus, Ohio

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I. Inaugural Address: Impressions of Operation Crossroads

Harold C. Hodge, Ph.D., School of Medicine and Dentistry, Rochester, N. Y.

Under the able leadership of Vice Admiral Wm. P. Blandy, the organization of Joint Task Force 1 was entirely comparable in magnitude to one of the amphibious operations of the war. However, in addition to the customary problems of supply, operations, and security; the work anticipated at Bikini lagoon involved a major problem of safety. This problem was of such magnitude and so unusual that a special section, the Radiological Safety Section, was set up under the direction of Col. Stafford L. Warren of the Army and Captain George Lyon of the Navy. This section is proud of the summary which can be made of its activities; not one man is known to have been injured by the special hazards of the atom bomb tests.

ABLE DAY

On ABLE DAY the bomb was dropped from a bomber high in the air, as were the bombs dropped at Hiroshima and Nagasaki. The bomb exploded high in the air over the target fleet; from which height the bomb exhibited a maximum of concussion force (blast effect) and of heat destruction—but a minimum of radioactivity was left on the surface. By "maximum blast effect" is meant the force

[1] Sessions of the International Association for Dental Research preceded, by agreement, the Annual Meeting of the American Association of Dental Schools, in the same hotel, June 23–25 and the Annual Meeting of Omicron Kappa Upsilon on June 24.

[2] The General Secretary of the Association, E. H. Hatton, rendered invaluable assistance to the Editor in preparation of these Proceedings.

which reduced the hearts of the cities of Hiroshima and of Nagasaki to rubble, with the exception of certain modern earthquake proof buildings still standing, but in which walls and floors were so disturbed and twisted that demolition may be necessary. At Bikini, the blast effect accounted for the immediate sinking of several big ships. By "a maximum of heat destruction" is meant the kind of heat which left a shadow of a Japanese pedestrian on the pavement some $\frac{3}{10}$ of a mile from the zero-point over Nagasaki. The shadow was used to help fix the exact point of explosion by having a soldier stand in the footprints of the Japanese pedestrian, and sighting from the apex of the shadow over the head of the soldier to the point where the bomb exploded. The shadow was the unburned part of the pavement. By a "minimum of radioactivity" is meant so little radioactivity that when our forces entered Hiroshima and Nagasaki, some six weeks after the bomb drops, nowhere on the surface of the ground was there an amount of radioactivity even remotely comparable with the amount present on the dial of a luminous-faced watch. I wish to repeat—when the bomb exploded high in the air the blast effect is maximal, the heat effect is maximal—but the radioactivity remaining is minimal.

The reason the radioactivity is minimal should be made clear: At the instant of the detonation, the upper half of the explosion went immediately toward the stratosphere, carrying with it a large share of the radioactivity. This half of the explosion formed the puff ball at the top of the famous mushroom cloud. The lower half of the explosion drove with enormous velocity toward the surface of the water, struck with terrific force, and rebounded to form the lower part, the pillar, of the mushroom cloud. Most of the radioactivity in this part of the explosion was therefore also carried up into the stratosphere. At great heights, the total radioactive matter was mixed with air, diluted, and dispersed. Carried by the air currents, it may have encircled the globe. Only traces remained on the surface of the lagoon.

From the air Bikini was a long, narrow expanse of green, surmounted on the eastern aspect by the white coral reef. This tiny island, roughly one mile by one-quarter, was the only substantial piece of land for many miles in any direction. In the lagoon off the island of Bikini was the impressive array of the target fleet at anchor. The battleship NEVADA, center of the target fleet, was painted a brilliant orange-red, except for the top of the ship and the installations. This color made it a striking target for the bombardier high in the air. Ironically, there was enough overcast so that the bombardier could not see it on ABLE DAY.

Army material of all sorts was placed on the decks of the target ships to be exposed to the effects of the atom bomb; it was a veritable museum of Army equipment. There was a huge 47-ton tank, a duck, a jeep, a seemingly endless array of guns—from giant howitzers to BAR. Some experimental animals were also distributed in strategically-chosen locations throughout the target fleet to obtain maximum information about the effects of the atom bomb on living creatures.

Just before 9:00 o'clock on the morning of ABLE DAY, a group of specialists under Capt. Fred. Bryan, M.C., assigned to a gun boat, were gathered amidships

at the command of "All hands on deck." At the direction of the skipper we turned our backs to the Bikini lagoon, 18 miles west of us, and faced the mid-morning sun. We closed our eyes and covered our eyes with one arm. Standing in this position we heard over the radio, through much static, the bombardier call, "Bomb away," and the metronome ticking off the last seconds. Suddenly there was the sensation of a flash of light. We distrusted this sensation because one sometimes gets "flashes of light" by closing the eyes in broad daylight; but a second later, when it felt as if someone slowly brought a hot iron up behind our heads and slowly removed it, we were no longer in any doubt as to whether the bomb had exploded. There was a clearly-discernable heat wave at a distance of 18 miles! We turned then and watched the mushroom cloud start to ascend. It was full of color, especially browns and yellows, from the nitrogen oxides produced by the extraordinary heat and radiation. (The ball of fire has a temperature estimated to be of the order of 100 million degrees Centigrade.) A sound like that of a distant blasting came over the water. In a few minutes the cloud reached a height of about 25,000 feet, at which point a lovely scarf cloud of ice crystals seemed to grow out over the top of the ball. In a minute or two more the cloud had reached its final height of approximately 40,000 feet; the ball part of the cloud, at that time about five miles across, still retained a yellow tint.

In a few minutes, as we watched, the mist and smoke at the base of the cloud cleared sufficiently for us to see the red-painted mast of the NEVADA—the target ship was still afloat. We felt a sort of disappointment, because, from our position, it was impossible to tell that *any* ships had disappeared from the target fleet. In the succeeding two hours long streamers of black smoke from the burning vessels drifted across the lagoon. We watched these evidences of damage with a great interest. Another extraordinary sight went on overhead—mother airplanes guided radio-controlled drone aircraft through various parts of the cloud to collect radioactive dust in special filters.

As we entered the lagoon, we were first aware of the effects of the heat: blackened, charred paint; vessels afire. Then we became aware of the curious pattern of the bent and twisted masts; many masts were bent nearly at right angles, and on the various ships around the center of the target area, masts were always bent away from the center. Some of the ships' funnels appeared crumpled. In skirting the target fleet, we passed one ship capsized, hull awash, that sank a few hours later. On ABLE DAY afternoon we watched the aircraft carrier INDEPENDENCE burn fiercely; explosions aboard sent gigantic white smoke rings hurtling into the air; a dull glow of fire came from the stern of the ship. The Japanese cruiser, SEGAWA, which sank on the morning of ABLE plus one, seemed crushed and twisted. The enormity of the damage awed us.

BAKER DAY

There was an important difference in events after the BAKER DAY explosion. This bomb was exploded by radio signals sent from a ship (the CUMBERLAND SOUND) several miles away. When the bomb went off, a sub-

stantial part of the radioactive materials were caught in the seawater; and, in addition, the neutron emission converted some salt of the sea water into radioactive sodium and radioactive chlorine. The water, containing various radioactive materials and, incidentally, powdered coral, was thrown high in the air, turned and cascaded down over the ships in the center of the target fleet.

I would like to emphasize the magnitude of the radioactivity in this sea water: In our hospital clinic, we have a few milligrams of radium. These few thousandths of a gram are treated with great respect; many health rules are laid down for the safety of those whose work includes the handling of this material. Special, long-handled instruments are provided; the workers carry pieces of film in the pockets of their laboratory coats; blood counts are made at frequent intervals; and the workers are required to take four weeks of vacation each year. Such precautions are taken with a few milligrams of radium. There are a thousand milligrams in a gram; there are one million grams in a ton; and the water on BAKER DAY contained the equivalent (in gamma radiation) of several thousand tons of radium. Man has never seen before such a stupendous radioactive hazard.

As the BAKER DAY bomb exploded, a column of water was driven skyward in a twinkling, and then the spreading pressure wave with its attendant fog obscured the scene. When the fog evaporated, the water column, one-half mile across, was still ascending. The column of water extended more than two miles in the air, and the top was nearly three miles across—twenty million tons of water. As the column of water began to descend, a tremendous breaker, a wave 600 feet high, arose, which subsided as it traveled toward the island so that it was only a few feet high when it reached the shore. A tremendous mist cloud full of radioactivity drifted along the surface of the lagoon, permeated the ships, and was carried downwind, dropping radioactivity onto the surface of the ocean in an area nearly twenty miles wide and forty miles long. In this area, dangerous radioactivity existed for many hours.

The mighty SARATOGA sank on BAKER DAY afternoon before anyone could get aboard. Tugs sent to tow her into shallow water could not approach close enough to get hold of her anchor chain, because the radioactivity was so intense.

After periods of hours or days the ship-washing processes started; and in due time boarding parties were permitted to inspect the damage. Always a "geiger-man" from the Radiological Safety Section accompanied or preceded such a party and decided whether it was safe for man to stay aboard for ten minutes, one hour, or all day.

Some of the precautions might be mentioned: Shoes became so heavily contaminated that they were dangerous and, when cleaning was impossible, they had to be discarded—fifty thousand pairs were thrown away. Rust in pipes inside ships became contaminated; bunks near these pipes were evacuated. If the rust and paint on the sides of ships became sufficiently contaminated, the outermost bunks next to the hull were evacuated. The big evaporators, which prepared drinking water, accumulated such large amounts of radioactivity in

some ships that engineers could only work a fraction of their working day. Everywhere all possible hazards were anticipated and checked. Some of the ships, even after the most diligent washing, could not be rendered safe. A few of these were taken out into the ocean and sunk. Others were towed to Kwajalein, to our own coast, or elsewhere where disposition has not yet been decided.

A brief comparison might make the problem growing out of BAKER DAY test more easily appreciated. The water on BAKER DAY contained the equivalent of several thousands of tons of radium. This figure should be contrasted with the amounts of radium remaining in the bodies of some of the women employed during World War I as radium dial painters. These women, despite all safeguards, persisted in tipping on their tongues the brushes they were using to apply radium paint to airplane dials. Those unfortunate enough to retain lethal amounts of radioactive material died of cancer from radium deposited in the bones; deaths were recorded five, ten, and even fifteen years later. One of the women who died nearly fifteen years after exposure had in her body at that time only one-millionth of a gram of radium. Contrast these two quantities: the equivalent of several thousands of tons of radium in the water vs. one-millionth of a gram of radium retained in the body producing death by cancer in fifteen years. No wonder the medical men in charge of the Bikini tests have repeatedly given us warning. The frightening possibilities must not be ignored.

A committee headed by Dr. Albert Einstein has given us 6 statements of fact: (1) Atom bombs can now be made cheaply and in large numbers. They will become more destructive. (2) There is no known defense against atom bombs, and none is to be expected. (3) Other nations can rediscover our secret processes by themselves. (4) An atomic armament race is futile, and if attempted will ruin the structure of our social order. (5) If war breaks out, atom bombs will be used and they will surely destroy our civilization. (6) There is no solution to this problem except the international control of atomic energy and, ultimately, the elimination of war.

II. Index of Participants, and Sequence Numerals of Corresponding Abstracts

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III. First Session: Morning; June 21; Abstracts 1–9

1. Micro estimation of vitamin c in human blood. *B. F. Gurney, M.S. and G. W. Rapp, Ph.D., Dental School of Loyola University, Chicago College of Dental Surgery, Chicago, Ill.* Plasma ascorbic acid can be determined colorimetrically by means of the osazone reaction on 2 or 3 drops of blood from a finger puncture. The procedure is quite specific for both reduced and oxidized forms of vitamin C. The method is made possible through an adaptor on the Lumetron Photoelectric colorimeter for a specially designed micro cuvette. The method is relatively simple and the results are remarkably reproducible.

2. Amino acids in human saliva. *E. R. Kirch, Ph.D., R. G. Kesel, D.D.S., M.S., J. F. O'Donnell, M.D. and E. C. Wach, D.D.S., M.S., College of Dentistry, University of Illinois, Chicago, Ill.* The salivas of 18 persons were assayed for various amino acids using the microbiological procedures. Sixteen of these substances were found to be present in these salivas in measurable quantities. A relationship between the amino acid content of the saliva and caries activity could not be established. (Published in *J. D. Res.* **26:** 297, 1947.)

3. Solubility of intact enamel. *Finn Brudevold, D.D.S., Tufts College Dental School, Boston, Mass.* A method has been developed for testing quantitatively the surface solubility of enamel in acid. The tooth is covered with wax except for a standard-sized window, and after exposure to acid the amount of dissolved P is analyzed according to a modified method of Fiske and Subbarow. Using a buffer pH 4, surface solubility of deciduous teeth was found greater than solubility of permanent teeth. Unerupted tooth surfaces are more soluble than erupted surfaces. There is wide and overlapping variation within each of these groups, averages being: Deciduous teeth 12.8 gamma, unerupted teeth 14

gamma, and erupted teeth 8 gamma. Brown pigmentation of enamel is frequently associated with low solubility. Cracks in enamel apparently do not affect the surface solubility. Preliminary results indicate that there is no relation between age and surface solubility. In 40 permanent teeth 4 consecutive exposures of the same surface to acid for 10 min. periods gave averages of 7.7, 10.4, 10.3 and 10.7 gamma. First run showed lower P values in 85% of teeth, indicating that the surface is more acid resistant than deeper layers. Identical averages for 5 impacted teeth were 14.0, 12.9, 11.1 and 12.9 gamma, 3 showing slight acid resistance of the surface, while the surface of other 2 was more soluble than deeper layers. Solubility of different areas on one tooth may vary as much as 50%. In 30 areas on 12 erupted teeth average deviation was 19.5%. Areas subject to abrasion show increased solubility, but other factors contribute to this variation. In 6 areas on 3 impacted teeth average deviation in solubility on each tooth was 17%.

4. METHOD FOR QUANTITATIVE ESTIMATION OF AMMONIA IN SALIVA. *J. Waide Price, Ph.D., and Sholom Pearlman, D.D.S., Institute of Pathology, Western Reserve University, Cleveland, Ohio.* The method consists essentially of direct Nesslerization of a Somogyi zinc filtrate of saliva, and comparison of resulting color values with standard curve, using Klett-Summerson photoelectric colorimeter. Reagents required are (a) 10% $ZnSO_4 \cdot 7H_2O$ solution; (b) approximately 0.6 N NaOH adjusted so that 10 ml of zinc sulfate require 9.0 ± 0.2 ml of alkali to give permanent pink color to phenolphthalein; (c) Koch-McMeekin modification of Nessler's solution; (d) 2% gum ghatti solution; (e) standard solution containing 1 mg of ammonia-nitrogen per ml. Pipette 0.5 ml of zinc sulfate into each of 2 tubes, one for specimen and one for reagent blank. Add 8 ml of water to each specimen tube (9 ml to blank). Add 1 ml of saliva and, after mixing by inversion, allow to stand for 2 minutes. Add 0.5 ml of NaOH, mix thoroughly, and centrifuge at 2,000 r.p.m. for at least 5 minutes. Place 2 drops of gum ghatti in bottom of labelled colorimeter tubes. Remove from centrifuge and transfer 5 ml of supernatant fluid to labelled colorimenter tube. Add 1 ml of Nessler's solution, and whirl solutions immediately by striking bottom of tube with fingers. Read color 30 to 45 minutes later with Klett-Summerson photoelectric colorimenter, using a 54 green filter, with blank set at zero. The standard curve must be established by adding 0.5 ml and 1.0 ml of standard solution to 1 ml of several salivas, treating as outlined, and subtracting reading for saliva alone from readings obtained when standard was added. When these residual values are plotted against concentration of ammonia-nitrogen, line obtained represents colorimeter readings for solutions of ammonia-nitrogen in saliva, and may be used for determining subsequent unknowns. Method affords an accuracy of ± 8 per cent. Ammonia formation in specimen is arrested on mixing with zinc sulfate. Estimations may be performed conveniently and rapidly, and presence of 10 gamma of ammonia-nitrogen is detectable. Dextrose interferes with Nesslerization, but in this dilution effect of small amounts of normal salivary dextrose is apparently eliminated.

5. PREVALENCE AND SEVERITY OF ENDEMIC DENTAL FLUOROSIS IN UNDERNOURISHED CHILDREN IN TWO ENDEMIC FLUORINE COMMUNITIES IN ITALY. *I.*

Schour and M. Massler, College of Dentistry, University of Illinois, Chicago, Ill. The prevalence of endemic dental fluorosis and the index of dental fluorosis were computed in children 12–14 years of age who had resided continuously from birth in 2 Italian communities using communal fluorine-containing water supplies. Both the prevalence of mottled teeth and the degree of mottling were found to be significantly greater in comparison with those reported by Dean (1942) for communities in the United States with similar concentration of F in the communal water supply. (Campagnano de Roma, 3.5 p.p.m. F, 2.5 dental fluorosis index, 100% population affected; Quarto, 1.5 p.p.m. F, 1.2 fluorosis index, 60% affected; Conway, S.C., 4.0 p.p.m. F, 2.1 fluorosis index, 88.2% affected; Elmhurst, Ill., 1.8 p.p.m. F, 0.67 fluorosis index, 40% affected.) These differences may be explained on the basis of the different nutritional status of the groups studied. The Italian children in Quarto and Campagnano de Roma were poorly nourished from birth on in comparison with the children in the American communities. It would appear from this study that a lowered nutritional status resulted in an increased prevalence and a higher degree of mottling in the teeth of children using a fluorine-containing communal water supply.

6. THE EFFECT OF DISTURBANCES IN MINERAL METABOLISM ON THE DENTIN AND PULP OF THE INCISOR OF THE WHITE RAT. *J. T. Irving, Ph.D., M.D., J. P. Weinmann, M.D., W. R. Tweedy, Ph.D., and I. Schour, D.D.S., Ph.D., Sc.D., College of Dentistry, University of Illinois, Chicago, Ill.* The dentin and pulp of the upper incisor of white rats were studied in histologic sections in 6 groups after 48 hours experimental period. Group A. Control (9 animals), Group B. Subcutaneous injection of massive doses of calciferol (9 animals), Group C. Subcutaneous injection of parathyroid extract (10 animals), Group D. Total nephrectomy (22 animals), Group E. Nephrectomy plus injection of calciferol (40 animals), Group F. Nephrectomy plus injection of parathyroid extract (28 animals). *Findings:* 1. In all instances of experimental disturbances of the mineral metabolism, continuously growing dentin showed changes that followed the typical pattern first described by Schour and Ham (1934) and Schour, Tweedy and McJunkin (1934). It consisted of 3 consecutive layers: a) a line called the calciotraumatic line; followed toward the pulp by b) a hypocalcified layer of dentin; c) a hypercalcified layer. 2. Using these landmarks the rate of dentin apposition was measured. It was found that the rate of dentin formation during the 2 experimental days was normal after injection of calciferol, increased after nephrectomy, and reduced after injection of parathyroid hormone. The increase in the rate of dentin formation following nephrectomy was not altered with the administration of calciferol but slightly reduced following injections of parathyroid hormone. 3. Ectopic calcification in the pulp was observed in almost all cases following the injection of parathyroid extract, in a few cases after nephrectomy, and in no instance following injection of calciferol.

7. THE EFFECT OF ACUTE VITAMIN C DEFICIENCY UPON THE RESPONSE OF THE PERIODONTAL TISSUES TO ARTIFICIALLY INDUCED INFLAMMATION. *Irving Glickman, B.S., D.M.D. and Samuel Pruzansky, D.D.S., Tufts College Dental School, Boston, Mass.* A microscopic study was conducted to determine the effect of

acute vitamin C deficiency upon response of the periodontal tissues to artificially induced inflammation. Twenty-five young adult guinea pigs were used as experimental animals: 16 animals were fed a vitamin C free diet, 9 animals which received the same diet with daily supplements of ascorbic acid 1 mg. to 100 gms. of body weight served as controls. After 1 month a 10% solution of silver nitrate was applied with a cotton pellet left in position for 30 seconds to the labial gingiva in the mandibular central incisor area of all animals except 2 each of the C deficient and control groups. The animals were sacrificed 4 days following the drug application. In all of the silver nitrate treated animals there was deep pocket formation and necrosis in the treated area. However the microscopic defense features were markedly diminished in the C deficient animals. In these animals there were notable fewer inflammatory cells and new capillaries immediately beneath the periodontal pocket with a preponderance of fragmented degenerated collagen fibers. In the C deficient animals the underlying bone in the affected area presented osteoporosis and a bordering zone of degenerated osteoid tissue in the absence of osteoblasts. In the control animals bone formation was a prominent feature. (To be pushed in *J. D. Res.*)

8. THE EFFECT OF PANTOTHENIC ACID DEFICIENCY ON THE PERIODONTAL STRUCTURES OF MICE. *Barnet M. Levy, A.B., D.D.S., M.S., Washington University School of Dentistry, St. Louis, Mo.* Twenty-one day old mice of the closely inbred strain C57 black were placed on a synthetic diet deficient in pantothenic acid and sacrificed at varying time intervals. All animals showed progressive loss of hair over the back and rump, and either failed to gain, or lost weight. The jaws of sacrificed mice were decalcified and embedded in paraffin. Serial sections were cut and studied. Animals sacrificed after 1 week on deficient diet showed marked hyperemia of pulp. After two weeks, hyperemia disappeared, but the alveolar crest showed evidence of early resorption. After three weeks there was further resorption of alveolar bone and downward proliferation of the oral epithelium along the roots of the teeth. At this stage of the deficiency, there was resorption of bone between the roots of the molar teeth. Continued retrogressive changes in alveolar bone occurred during the next three weeks on the deficient diet. The epithelial rests proliferated, but there was no evidence of necrosis of oral epithelium. All animals were sacrificed after 6 weeks.

9. ADRENALIN AND ANALGESIA. *Stanley C. Harris, Ph.D., Northwestern University Dental School, Chicago, Ill.* The analgesic efficiency of morphine is legend, but the mechanism of this analgesia is obscure. That morphine elicits the secretion of adrenalin by the adrenal medullae is well established. Since it has been demonstrated that epinephrine itself is analgesic and that epinephrine-like compounds potentiate morphine analgesia, this experiment was designed to determine the role of physiologically produced epinephrine in morphine analgesia. The response of albino rats to tail pinching after 5 mg. of morphine sulfate (subcutaneously) per kilogram of body weight was determined on 5 separate occasions before and 5 separate occasions after bilateral adrenalectomy. To protect against cortical deficiency, the cortices were autotransplanted into the anterior chamber of the eye. Medullary tissue does not "take" in this pro-

cedure. An additional control experiment consisted of the same procedure before and after dummy operations. In all, 240 assays were performed on 24 male rats. In terms of distance between the prongs of the stimulating forceps, there was a 40% decrease in analgesic response to the standard dose of morphine after adrenalectomy and only a 6% decrease in response after the dummy operation. Statistical treatment of the data show tolerance to be of no consequence in this interpretation. Since epinephrine is analeptic while morphine is narcotic, it is possible that these findings suggests morphine analgesia is not entirely due to interference with the perception of pain.

IV. Second Session: Afternoon; June 21; Abstracts 10–21

10. The value of the roentgenogram in the detection of carious lesions. *Virgil D. Cheyne, D.D.S., Ph.D., and Eleanor V. Horne, B.A., College of Dentistry, University of Iowa, Iowa City, Ia.* One thousand six hundred and ninety-four (1694) single roentgenographic pictures were examined on 429 children in an effort to determine the relative proportion of cavities found by bite-wing and full mouth survey inspections to clinical findings. Detailed and complete clinical examinations were performed. Bite-wing films were studied on 329 individuals divided into 3 groups: Group 1, individuals from a state school for feeble-minded, were examined leisurely by painstakingly clinical methods. Group 2 children, from the same institution, were more hurriedly inspected by the same examiners. No significant difference was found between relative proportion of roentgenographic findings to clinical between the groups. Group 3, 101 individuals from the College of Dentistry, had a dental caries rate approximately twice that of those from the institution. Enamel lesions found were proportionately more common in the low-caries group, but the average figure per child showed no significant difference. A total of the groups demonstrated an additional 0.71 lesion per child found by bite-wing roentgenographs. This was 5.1% of the total. One hundred children having full mouth surveys demonstrated no significant sex difference in the amount of caries found (22 males and 22 females had negative roentgenographs). The average lesions per child found by the survey was 1.32; 6.1% of the total. This did not significantly change the total caries picture, although the number was approximately twice that found in bite-wing roentgenographs. The mean DMF tooth surfaces was not altered by either the bite-wing or full mouth films. (To be published in *J. D. Res.*)

11. Epidemiologic studies of dental caries among institutionalized children. *Julian D. Boyd, M.D. and Virgil D. Cheyne, D.D.S., University of Iowa, Iowa City, Ia.* The incidence and extent of dental caries have been measured in 619 children resident in 6 custodial institutions. Among younger children caries scores were higher than for a public school population; for teen-aged subjects who had been long term residents of the institutions the caries scores were significantly less than for the control group. No sex differences were noted. There was no relationship between the amount of prophylactic or therapeutic dental care and the respective caries scores. Fluorine ingestion played no apparent role in the collective caries patterns. The data support

the thesis that regimentation of living conditions in itself may modify caries experience, without evident relation to intra-oral environmental factors. Constancy of diet pattern, regularity and constancy of food intake, and freedom from certain emotional stresses each may be significant. The diets employed did not meet optimal nutritional standards, but they were better and more constantly dependable in certain regards than those ingested by the average child. They provided notable proportions of the total calories as starch and as sugar. This study is one of a series dealing with dental findings among specific groups of children, each living under such environmental conditions that certain of the variables encountered in the general child population can be eliminated from consideration. The complete series is planned ultimately to offer evidence as to the role various factors may play in the epidemiology of dental caries.

12. DETERMINATION OF THE NUMBER OF SURFACES INVOLVED IN CARIOUS EXTRACTED TEETH. *Kenneth E. Wessels, D.D.S. and Virgil D. Cheyne, D.D.S., Ph.D., State University of Iowa, Iowa City, Ia.* Three hundred and seventy seven extracted deciduous and permanent teeth from patients of the Children's Clinics of the College of Dentistry were examined, to determine the number of surfaces involved by caries. Each tooth is supported by a detailed clinical examination, and only those teeth which fell into the category of extractions due to caries is included. Data are presented on carious surfaces in extracted teeth according to sex, tooth type, and age. The mean number of tooth surfaces involved with noncarious enamel lesions, enamel caries, and dentinal caries is listed for each tooth type. The mean number of surfaces involved in the boy's permanent group is 4.378; in the boy's deciduous group, 4.096; in the girl's permanent group, 4.333; in the girl's deciduous group, 4.026. In comparing group means, a significant difference is found only between the boy's permanent and deciduous groups. There is no significant difference between girl's permanent and deciduous, boy's and girl's permanent, or boy's and girl's deciduous groups. The mean values for all first permanent molars is 4.340 surfaces, and for the remainder of the permanent teeth included in the study is 4.470, a difference which is not significant. The results of this study indicate that the tooth surface involvement of teeth extracted because of caries is higher than is generally assumed by those doing clinical caries research. For an accurate caries analysis, missing teeth must have the proper evaluation in relation to the remaining carious and filled teeth. Such a figure has been presented giving additional consideration to individual tooth types according to sex and age. (Published in *J. D. Res.* **26**: 375, 1947.)

13. LACTOBACILLUS COUNTS: NEWBURGH-KINGSTON FLUORINE DEMONSTRATION. *S. B. Finn and D. B. Ast, Department of Health, Albany, N. Y.* Lactobacillus counts done in Newburgh prior to fluorination of the municipal water supply and 1 and 2 years following fluorination reveal a consistent drop in counts of 20,000 or over and a rise in counts of less than 100. Although this may not be significant, it is in the direction one would expect if fluorination ultimately produces a reduction in dental caries. Lactobacillus counts done in Kingston, fluorine free control city, reveal no appreciable variation in high and low counts. (Published in *Science* **106**: 292, 1947.)

14. VARIATION IN DIET AND INCIDENCE OF DENTAL CARIES IN INDIA. *Kanwar L. Shourie, B.Sc., M.B.B.S., M.D.S., (Pb), India, M.Sc., School of Medicine and Dentistry, University of Rochester, Rochester, N. Y.* The relation between diet and dental caries has been studied on the basis of extensive diet and dental surveys carried out in various parts of India. Diet of 233 families were studied and dental caries incidence in about 12,000 persons was recorded. On the whole the incidence of dental caries was found to be low. The role of an excess of cereals in diet has been discussed and in the light of data collected in India it is inferred that use of predominantly cereal diet does not invariably go hand in hand with high incidence of caries. Observations indicate that the ingestion of low quantities of animal proteins and fats is not a causative factor of dental caries. It is further concluded that low calcium content of diet during the period of growth and development does not affect resistance to dental decay. The findings fail to substantiate the hypotheses purporting to explain dental caries in terms of deficiencies of vitamins A, B or D.

15. THE EFFECT ON HAMSTER CARIES OF TOOTHBRUSHING WITH VARIOUS CHEMICALS. *Joseph P. Lazansky, Tufts College Dental School, Boston, Mass.* In vitro tests showed that solutions of acidulated NaF, PbF_2, In $(NO_3)_3$, $BeSO_4$, and $YtSO_4$ were more effective in reducing enamel solubility than neutral sodium fluoride solutions. To determine whether these agents were more effective in reducing dental caries, groups of female hamsters were placed on a caries producing diet at weaning and subjected to brushing three times per week, using the test solutions on a mascara brush. Control groups using water brushing and no brushing were also run. After 120 days the animals were sacrificed and the teeth examined. The number of cavities found in relation to the non-brushed group was as follows: H_2O a 20% decrease, NaF a 60.7% decrease, PbF_2 a 36% decrease, Acid NaF a 56% increase, In (NO_3) a 59% increase, $BeSO_4$ a 30% decrease, $YtSO_4$ a 33% decrease. In extent of area involved in caries the following changes were noted: H_2O a 38% decrease, NaF a 87% decrease, PbF_2 a 74% decrease, Acid NaF a 95% increase, In $(NO_3)_3$ a 18% increase, $BeSO_4$ a 44.4% increase and $YtSO_4$ a 51.4% increase.

16. THE EFFECT OF TOPICAL APPLICATIONS OF LEAD FLUORIDE ON DENTAL CARIES. *B. G. Bibby, Eleanor De Roche, and Esther Wilkins, Tufts College Dental School and Mass. Dept. of Health, Boston, Mass.* On the basis of the in vitro demonstration that treatment of powdered enamel with acidulated lead fluoride almost completely prevented solution of powdered enamel in acetate buffer, whereas treatment with sodium fluoride produced only a 40% reduction of solubility, it was decided to test the inhibitory effect of topical applications of lead fluoride on dental caries in the teeth of children. Accordingly a group of 120 school children in Medford between the ages of 11 and 13 were treated 3 times at approximately 4 monthly intervals during a period of 1 year using a saturated lead fluoride solution in pH 4 sodium acetate-acetic acid buffer. Following a regular dental prophylaxis the upper left quadrant was treated in each mouth, the upper right quadrant serving as control. On mirror and probe re-examination at the end of 1 year no reduction of dental caries was noted

in the treated quadrants, whereas a similar treatment program previously carried out in Brockton using 0.1% sodium fluoride produced a 46% reduction in new dental caries.

17. STUDIES ON THE POLISHING POWER OF DENTIFRICES. *C. E. Alford, E. T. Hinkel, Jr., F. C. Nachod, M. Priznar and M. L. Tainter, Sterling-Winthrop Research Institute, Rensselaer, N. Y.* The degree of polish on extracted teeth may be measured by reflecting light from the polished surface of the tooth onto a photocell and measuring the current produced. For this purpose teeth can be mounted on an optical bench in the path of a parallel beam of light, and the reflected ray caught on the sensitive element in the photoelectric cell. The current generated, after suitable amplification, can be read on a microammeter. It will vary with the amount of light reflected, which in turn is directly dependent on the degree of mirror polish. Tests with representative polishing agents show that gradations in polishing power are readily demonstrated. The absolute current values can be transformed into activity relative to a standard of reference polishing agent if desired. The results are sufficiently uniform between teeth that statistically reliable conclusions may be derived without having to carry out excessively large numbers of determinations.

18. IN VITRO EFFECT OF SUBSTRATES, INHIBITORS AND ACCELERATORS UPON TOOTH PHOSPHATASE. *G. Bevelander and P. L. Johnson, New York University, College of Dentistry, New York, N. Y.* Previous studies by Bevelander and Johnson have shown the site of the enzyme alkaline phosphatase in each of the tissues which are present during the early development and calcification of the tooth. The possibility that other phosphatases may be associated with these processes led us to a study of the effect of diverse substrates, activators and inhibitors upon the enzymes involved in the differentiation and calcification of the dental tissues. Results of these studies were discussed.

19. HISTOPATHOLOGY OF THE DENTAL PULP OF DOGS AND GUINEA PIGS FOLLOWING EXPOSURE AND SODIUM FLUORIDE APPLICATION: PRELIMINARY REPORT. *Seymour J. Kreshover, G. Bevelander, and E. D. Goldsmith, New York University, College of Dentistry, New York, N. Y.* The present study was undertaken to investigate the sequence of histopathologic events following operative exposure of the pulp. Further experimental procedures permitted comparison with changes produced by injury other than exposure. Three dogs and 3 guinea pigs comprised the experimental material. Cavity preparations followed by exposure were made in 14 dog teeth and a disc of tin foil was placed over the exposure channel with a seal of gutta percha or cement. Similar preparations (without exposure) in which sodium fluoride was sealed, were made in 14 of the teeth. Four additional teeth were prepared with simple cavities lined with tin foil and cement filled. The pulpal tissues of the 14 exposed teeth showed gradations from acute to chronic inflammation and also necrosis, abscess formation, granulation tissue progressing to complete fibrosis, and formation of irregular secondary dentin. The most striking change, common throughout, was the presence of osteo-dentin-like masses of varying size and shape. In the non-exposed teeth treated with sodium fluoride, the significant changes were second-

ary dentin formation underlying the affected dentinal tubules, early abscess formation, and round cell infiltration with striking presence of large numbers of phagocytic macrophages throughout the pulp. No calcific changes were observed. Those teeth with cavity preparations alone, showed a hyperemia and acute inflammation of the pulp underlying the site of operation. Changes folling exposure in the guinea pig incisors were seen in enamel, dentin and pulp. Marked calcific changes in the latter structure were most prominent.

20. THE EFFECT OF WETTING AGENTS ON ORAL LACTOBACILLI. *Frank Walter and Harve Carlson, Dr. P. H., Western Reserve University, Cleveland, Ohio.* The effect of the addition of various surface-active agents on cultures of oral lactobacilli has been investigated. Stimulation and inhibition are demonstrated upon the addition of varied amounts of the agents in liquid and solid media. An indication of the potentialities of these findings is noted. (Published in *J. D. Res.* **26:** 353, 1947.)

21. ELECTRON AND OPTICAL MICROSCOPY OF TOOTH STRUCTURE BY THE SHADOWED REPLICA METHOD. *David B. Scott, D.D.S., M.S., and Ralph W. G. Wyckoff, Ph.D., National Institute of Health, Bethesda, Md.* Shadowed collodion replica technics afford a new approach to the study of tooth surfaces and problems of a general histological nature. Collodion replicas of tooth surfaces are prepared in situ or on extracted teeth by covering the surfaces with a dilute collodion solution and stripping off the films after they have dried. A thin layer of metal is then evaporated obliquely on to the replicas in a high vacuum chamber. The metal thus deposited causes the details reproduced on the replica to be brought out into bold tri-dimensional relief, due to the production of "shadows". The shadowed replicas are observed under the optical microscope. Studies are in progress on general surface characteristics, differences between carious and non-carious surfaces, fluorosed and non-fluorosed surfaces, and the effects of various chemical agents. Similar replicas are also prepared of lightly etched surfaces of ground sections, and studies are being made on characteristic tooth structures and the effects of various chemical agents on tooth substance. Thin replicas, suitable for electron microscopy, are made by applying more dilute collodion to the surfaces of lightly etched ground sections, or thin slabs cut to include the tooth surfaces. Tooth substance is removed by floating the sections in HCl and pepsin. The replicas are picked up from the surface of rinse water, shadowed, and observed under the electron microscope. Tooth structures are being studied at the high magnifications thus afforded, and experiments similar to those employing optical microscopy are being performed.

V. THIRD SESSION: EVENING; JUNE 21; ABSTRACTS 22–35

22. PAPILLARY CYSTADENOMA OF THE SALIVARY GLANDS. *Wm. H. Bauer, M.D., D.D.S., Saint Louis University, School of Dentistry, St. Louis, Mo.* The so-called mixed tumors of the salivary glands which reveal microscopically a variable amount of secreting epithelial and myoepithelial cells and contain myxomatous, pseudocartilagenous areas and even true cartilage must be separated from the papillary cystadenomas which lack a demonstrable participation of

the interstitial connective tissue in the formation of the tumor. These neoplasms are rare and their pathogenesis is of great interest. Among 85 tumors of the salivary glands studied microscopically 5 papillary cystadenomas were diagnosed. Two involved the parotid gland, 2 the roof of the oral cavity and 1 the lower lip. The cytologic details varied considerably from specimen to specimen. The papillae projecting into cavities which contained an eosinophilic substance were lined with cuboidal or cylindrical, mostly basophilic epithelium. In contrast to the cystadenoma papillare lymphomatosum (Warthin's tumor) the tumors described showed no lymphoid tissue whatever. Epidermoid proliferation was observed. Aggregations of sharply bordered "clear cells" which resemble the cells of the renal carcinoma (hypernephroma) were observed. Although malignant changes of the epithelial cells were absent, papillary projections penetrated deep into normal glandular tissue. The papillary cystadenoma of the salivary glands arises from the epithelium of the secretory ducts.

23. THE ACTION OF SALIVA ON STARCH AND GLUCOSE. *J. F. Volker and D. P. Murray. Tufts College Dental School, Boston Mass.* The "in vitro" rate of acid production of refined starch saliva mixtures has been found to parallel that of glucose saliva. Two overall steps seem necessary for acid production from starch: (1) starch breakdown to reducing sugars (2) sugar conversion to acid. If the first reaction is extremely rapid and the second limited, acid production from starch saliva and glucose saliva mixtures should be similar. Theoretically, if the breakdown of starch to reducing sugars could be drastically impeded, the rate of acid production of starch saliva mixtures might be reduced. Kneen and his associates have shown that natural wheat starch has a tryptophane containing amylase inhibitor and Turner has shown the ability of pure tryptophane to do likewise. We have shown that various plant hormones are effective in inhibiting starch breakdown to reducing sugars but, they do not influence the ability of saliva to break down glucose and sucrose to acid.

The "in vitro" rate of acid production of sucrose saliva mixtures has been found to parallel that of glucose-saliva. Two possibilities exist (1) the oral enzymes convert sucrose to acid without intermediate hexose formation (2) some of the sucrose in sucrose saliva mixtures is immediately converted to glucose and as such is used in acid formation. We have been able to show by in vitro experiments the presence of reducing sugars within 2 minutes after the addition of sucrose to fresh saliva. The level of glucose in saliva sucrose mixtures is dependent on the initial concentration of sucrose and tends to remain at a stabilized level over periods of at least several hours. If salivary samples are taken immediately after the ingestion of a sucrose ration, measurable quantities of reducing substance can be shown to be present.

24. A RADIODONTIC STUDY OF THE MENTAL FORAMEN: PART I. VISUALIZATION. *A. Porter S. Sweet, D.D.S., Eastman Kodak Company, Rochester, N. Y.* The mental foramen is an anatomical entity of considerable importance to the dentist because of its location and because its image is not infrequently misinterpreted radiographically as an area of osteoclasia. Five hundred and eighty-five periapical full-mandibular, radiodontic examinations of employees of a large manu-

facturing concern were used. Their ages ranged from 18 to 64 years; the average being 32.19 years. Two-film packets were used, one film from each packet being sent unprocessed to the investigator. All films were processed with the time-temperature technic, dried, mounted in dental film mounts, and examined with a magnifying glass. All the cases were divided into age quintades and into sex groups. A careful study should thus reveal whether or not there are any age or sex factors in mental foramen visualization. It was found that the mental foramen could be visualized on one or both sides in approximately 67%. While the female:male ratio and age averages seemed to stay fairly constant, this was misleading. When the same material was examined graphically there was definite indication that there is both an age and sex factor in the radiographic visualization of the mental foramen.

25. A CEPHALOMETRIC METHOD FOR DETERMINING DEFICIENCIES OF GROWTH IN THE MANDIBLE. *Herbert I. Margolis, Tufts College Dental School, Boston, Mass.* The level of development of component parts of the mandible (rami and body) may be determined by correlation with the maxillo-facial triangle constructed by the author as a reference area on the sagittal cephalic x-ray. The anterior limit of body of mandible is its tangent on facial line of the triangle, posterior limit is established at gonial angle. Height and antero-posterior width of rami are also measured within this cranio-facial-mandibular triangle. The well developed face of modern man in morphologic and physiologic balance presents a maxillo-facial triangle which falls into a significant pattern independent of race. Disharmony or deformity in mandible may be recognized and measured in location and degree by corresponding changes in reference area and by correlation with proportion of face and occlusion of teeth. Mandibles of 50 children between the ages of 9 and 16 having Angles Class II, division 1 malocclusion were measured. Although dental malocclusions were similar, level of development of mandibles was quite dissimilar and showed no correlation with malocclusions. Some mandibles were well within the limits of the range of normal development, others manifested deficiencies either in rami or body or in entire mandible. Although there may be etiologic correlation between malocclusion and phylogenetic or ontogenetic origin, there is no constant morphologic correlation between dental irregularities and development of basal portions of mandible. It is obvious that differential diagnosis based only on dental casts is inadequate and that treatment based simply on casts may be entirely misleading. Further studies by such standardized cephalic x-ray records correlated with treatment are warranted to advance the clinical practice of orthodontics.

26. CORRECTION OF ERROR IN CEPHALOMETRIC HEAD FILMS WITH THE COMPENSATOR. *W. A. Elsasser, A.B., D.D.S., School of Dentistry, University of California, San Francisco, Cal.* Adams has provided for correction of the slight amount of size distortion in Broadbent-Bolton cephalometric head films, a method which is applicable to lateral films. The "compensator" has been designed for use on both lateral and frontal films, making calculations unnecessary and making possible an undistorted vertical projection of craniofacial structures to supplement the lateral and frontal films. It consists of a bedplate of lucite

engraved with 2 lines at right angles to one another, representing the median sagittal plane and the porionic axis. One border is an arc whose center is 5 feet from the intersection of the 2 lines, i.e., the anode of the tube. A sliding member traverses the surface of the bedplate following the curved border, so that its edges always reproduce radii of the circle (or x-rays). Since it is essentially a "model" of the rays in full scale, one can use the 2 films to create a vertical projection on millimeter paper fastened to the bedplate, because ray divergence is reproduced and all other quantitative measurement may be read directly.

27. MIXED DENTITION CASE ANALYSIS: PREDICTING WIDTH OF UNERUPTED TEETH. *W. L. Wylie, D.D.S., M.S., and M. L. Ballard, B.S., D.D.S., College of Dentistry, University of California, San Francisco, Cal.* It is desirable that orthodontists know the mesio-distal width of the mandibular canine, first premolar and second premolar of each side when children present for treatment in the mixed dentition. These dimensions may be taken from radiographs, but this has definite limitations. The prediction formula, $X = 9.41 + 0.527Y$, where X equals the sum of the mandibular canine, first premolar, and second premolar of one side, and Y equals the sum of the 4 mandibular incisors, is based on width measurements taken from 441 sets of plaster models. Reliability of the formula was checked on 60 cases by measuring unerupted teeth in mixed dentition radiographs on one hand and predicting their width from the incisor width on the other. Accuracy of each was checked by measuring models taken after teeth had erupted. The average error from films was 10.5% (2.2 mm.), and 2.6% (0.6 mm.) from the formula. A nomogram made from the formula is used for convenience. The formula $X = 5.52 + 0.431Y + 0.552Z$ where X equals the sum of the canine and premolars, and Y equals the sum of the mandibular incisors, and Z equals the mesio-distal width of one lower first permanent molar may be used but it does not improve predictions sufficiently to make it worth while.

28. HISTOPATHOLOGY OF PREGNANCY GINGIVITIS. *Balint Orban, M. D., D.D.S., and A. W. Maier, M. D., D.D.S., School of Dentistry, University of Illinois, Chicago, Ill.* The incidence of gingivitis in pregnant women was studied on 500 cases. Biopsy specimens were taken of cases with varying degrees of gingivitis. In beginning gingivitis no features characteristic of pregnancy gingivitis were found. In more advanced cases, epithelial proliferation and capillary proliferation seem to be predominant. In so-called pregnancy tumors, proliferative changes were most characteristic. Proliferation was found in the epithelium, connective tissue and capillaries. A pseudomembranous ulceration of the surface of the 'tumor' was often found with fibrinous thrombosis of the surface capillaries.

29. THE BEHAVIOR OF THE PULP HISTIOCYTES OF THE MOLAR TEETH OF VITALLY STAINED RATS. *Philip Burwasser, D.D.S., Ph.D., Western Reserve University, Cleveland, Ohio.* White rats ranging in age from new-born to adult were injected with minimal to moderately large doses of trypan blue dye. The pulp histiocytes stored the dye in smaller sized particles than occurred in the tissue macrophages. The constant characteristic difference in the size of the granules

of phagocytosed dye represents a difference in phagocytic activity between the pulp histiocytes and tissue macrophages, which is probably due to environmental factors. The variation in phagocytic behavior does not imply that the pulp histiocytes are essentially different from the tissue macrophages. The pulp histiocytes do not arise from tissue macrophages, but rather by differentiation of the growing pulp cells and from the adventitial cells of the pulpal blood vessels. In older animals there was a reduction in the number of pulp histiocytes. It was not possible to induce the new formation of pulp histiocytes in adult teeth by repeated injections of trypan blue.

30. SALIVARY CITRATE CONTENT IN PATIENTS WITH AND WITHOUT EROSION. *Eli H. Shulman, D.D.S. and Hamilton B. G. Robinson, D.D.S., M.S., College of Dentistry, Ohio State University, Columbus, Ohio.* Small quantities of citrate have been reported in saliva and McClure and Ruzicka (*J. D. Res.*, **25**: 1, 1946) demonstrated that feeding citrate containing fluid to rats resulted in erosion-like dental lesions. An examination of 1345 freshmen at Ohio State University showed 28 cases (2%) of dental erosion. By method of Deysher and Holm, saliva from 15 of these students was studied: 4 showed zero to traces of citrate, 2 from 0.2–0.6 mg/100 cc., 3 from 0.6–0.9 mg/100 cc., 1.2–1.5 mg/100 cc. Of 25 individuals without erosion, 9 had 0–traces of salivary citrate, 4 had 0.4–1.0 mg/100 cc., 5 had 1.0–1.35 mg/100 cc. and 7 had 1.35–1.55 mg/100 cc. All saliva was paraffin stimulated and 100 cc. was collected at a time. Although there was no significant quantitative difference between salivary citrate in individuals with and without erosion there is no evidence presented to show that erosion was active at the time of collection of saliva and no studies were made to ascertain whether there was a protective factor against citrate in the saliva or teeth of those having relatively high salivary citrate concentration and no erosion.

31. ADAPTABILITY OF THE ATTACHMENT APPARATUS. *M. S. Aisenberg, Baltimore College of Dental Surgery, Dental School, University of Maryland, Baltimore, Md.* Several types of functional repair of the attachment apparatus have been described in literature. Another variant showing a peculiar adaptability of repair is presented, to confirm a statement made by the author in 1938, "where the space is wide, new bone with new periodontal fibers attached to newly deposited secondary cementum on the dentinal surface will result. In some cases ankylosis occurs, especially when the tooth is in good functional activity". (Published in *J. D. Res.*, **26**: 421, 1947.)

32. DIFFUSE FIBROMATOSIS OF THE GINGIVA: CLINICAL AND HISTOLOGIC FINDINGS. *Emmett R. Costich, D.D.S., School of Medicine and Dentistry, University of Rochester, Rochester, N. Y.* The findings of clinicians reporting cases of fibromatosis of the gingiva was correlated, along with those cases seen in the Strong Memorial Hospital in an effort to make easier the establishment of a diagnosis in such cases.

33. MANDIBULAR MEASUREMENTS. *J. R. Jarabak and Maclyn Kamms, School of Dentistry, Northwestern University, Chicago, Ill.* Gross mandibular measurements have been the object of many anthropologic studies. The purpose of this study is to determine the trend of measurements of component parts of the

mandible, primarily the body and the ascending rami, with the object of (1) determining the variations of measurements in body length of right and left side and (2) the variations of the measurements of the rami of the right and left side, and (3) to determine whether there is any correlation in these measurements which when applied to a known measurement of either the body or the rami will determine the length of the other. From the data it would be impossible to establish a definite formula for determination of the measurement of either body length or ramus height with known measurements of only one of these factors with any great degree of accuracy. Given the measurement of one factor one can approximate measurement of other in 70% of cases (this would apply to skulls in which the dentures were in normal occlusion). The mandibular index representing a percentage of the ramus height to the body length may be significantly more reliable in appraisal of measurement of the body or ramus. The composite indicates that ramus height is approximately 65% of body length with a mean deviation of about 4.5%. Study of the actual measurements of these mandibles indicates that deviation is rather large in body and rami, however, plotting of given points once again indicates that in relatively high percentage (70%) measurements lie close to average ± of the mean deviation.

34. ARTIFICIAL REDISTRIBUTION OF CALCIUM SALTS IN ENAMEL BY MEANS OF ACID APPLICATION. *Harold B. Younger, College of Dentistry, Baylor University, Dallas, Tex.* Gottlieb and Stanton claimed that the calcium salts in the enamel can be shifted by acid action. On this evidence a study was made of the clinical effect of various methods of applying acid to the surface of enamel disfigured with brown stain and mottling from fluorine in the drinking water. A method was found which produced excellent clinical results. A paste was made of 27% hydrochloric acid and flour of pumice. This was polished onto the dried labial surfaces of the affected teeth with a rubber prophylaxis cup in the hand piece of the dental engine at a low speed for 2 minutes. A saturated solution of bicarbonate of soda was then applied to neutralize the acid and the teeth washed with water. The teeth were again dried, and 30% hydrogen peroxide polished onto the surfaces of the teeth with the rubber cup at high speed for 1 minute and the teeth washed with water. Three or 4 such treatments were sufficient to obtain the desired clinical effect.

In order to microscopically study the effect of this treatment on the enamel intact extracted teeth were used. The lingual, and one proximal surfaces were covered with sticky wax and the buccal, or labial, and the other proximal surfaces were treated 3 times. Transverse ground sections were made and examined microscopically. No significant loss of enamel thickness could be observed in the treated areas. One tooth was by chance a fluorine tooth, showing mottling on the untreated sides. The tufts as well as the prism sheaths were covered by the shifted calcium salts, with resulting appearance of homogenosity similar to transparant enamel. Some lamellae were lightened and some apparently disappeared entirely, judging by a comparison of the number to be seen in the treated and untreated areas.

35. BARRIERS OF HYPERCALCIFIED DENTIN UNDER FILLINGS VISIBLE IN THE

RADIOGRAPH. *H. M. Crawford, D.D.S., College of Dentistry, Baylor University, Dallas, Tex.* In ground sections of teeth with unfilled open cavities it has been shown that both hypercalcified enamel, appearing transparent, and hypercalcified dentin, appearing opaque, are reliable barriers against the progress of dental caries. These hypercalcifications have been explained as resulting from the shifting of calcium salts from areas of decalcification into the adjoining tooth structure. Opaque dentin has been proved by Grenz rays to be hypercalcified. Distinct areas of hypercalcification could be observed under some fillings in routine radiographs. These areas were separated from the filling by strips of decalcified dentin. Ground sections of teeth with fillings were found to have signs of decalcification coupled with yellow pigmentation surrounded by an opaque hypercalcified barrier under the fillings in a majority of cases. The following explanation is offered: When the teeth were filled, acidogenic microorganisms were left in the tubules lining the cavity. These produced acid which decalcified the immediate dentin, liberating calcium salts which reprecipitated in the periphery, causing hypercalcification there. In the open cavity a part of the mobilized calcium salts are washed out by the saliva. Under fillings no calcium salts are lost and the entire amount is available for hypercalcification in the periphery.

VI. Fourth Session: Morning; June 22; Abstracts 36–49

36. Laboratory and animal studies on the effect of penicillin on caries activity. *H. A. Zander and B. G. Bibby, Tufts College Dental School, Boston, Mass.* In vitro experiments demonstrated that small amounts of penicillin, added to glucose-saliva mixtures, interfered with carbohydrate breakdown. The use of penicillin toothpastes and mouthwashes by student subjects reduced acid production in saliva glucose mixtures even in the absence of marked changes in the oral flora. Neither eating nor smoking reduced the efficacy of penicillin. Hamsters whose teeth were brushed daily with penicillin toothpaste for 34 days showed an average of 1.14 carious teeth per animal; the control brushing group averaged 3.87 carious teeth per animal; the control group (no brushing) averaged 9.25 carious teeth per animal. All animals were on the same caries-producing diet.

37. Effect of penicillin dentrifrice on oral lactobacillus counts. *Thomas J. Hill, D.D.S. and Albert H. Kniesner, B.S., D.D.S., School of Denistry and Institute of Pathology, Western Reserve University, Cleveland, Ohio.* Two hundred and forty institutionalized boys ranging in age from 8 to 16 years inclusive are being studied for changes in dental caries susceptibility with the use of a commercially prepared powdered dentifrice containing 500 units of penicillin per gram. The average of 2 lactobacillus counts was accepted as the initial degree of susceptibility. All salivary specimens were collected before breakfast and before brushing the teeth. One hundred and fifty-four boys were given the penicillin-containing powder and 86 were given plain tooth powder. They were instructed to brush their teeth with this dentifrice twice a day. An arbitrary classification of susceptibility followed was 0 to 100 per ml. saliva, negative; 100

to 1,000, ±; 1,000 to 10,000, +; 10,000 to 30,000, ++; 30,000 to 50,000, +++; 50,000 and over, ++++. No change in susceptibility was recorded unless the count passed at least half the range of adjacent classifications. Preliminary findings at 5 months revealed that the susceptibility of the control group decreased to negative counts in 9% of the individuals, and of the experimental group, 21%. Of those whose susceptibility changed, an increase in susceptibility was observed in 20% of the controls and only 4% of the penicillin group. Of the controls, 43% decreased in classified susceptibility and 65% of the penicillin group decreased.

38. EFFECT OF PENICILLIN ON INCIDENCE OF DENTAL CARIES IN RATS FED ON COARSE CORN. *Harold Webman, B.S., D.D.S., A. H. Kniesner, B.S., D.D.S., and T. J. Hill, D.D.S., School of Dentistry, Western Reserve University, Cleveland, Ohio.* One hundred and twenty-six rats were fed a coarse corn caries-producing diet (Hoppert) beginning at 25 to 30 days of age and continued for 110 days at which time the rats were sacrificed. Additions of penicillin and sucrose were made to the water supply. The number of carious teeth produced in the water control group was not reduced significantly by adding 5 units of penicillin per milliliter of water. In the sucrose control group which was given sucrose, 1.5% in water, 22.5% of the teeth became carious. When the 1.5% sucrose solution was supplemented with 2 units of penicillin per milliliter, 16.6% of the teeth became carious, or a reduction of 26%. To another group 5 units of penicillin per milliliter were added to 1.5% sucrose solution, and only 9.3% of the teeth became carious, or a reduction of 59%. As increments of penicillin were added, the frequency of lactobacilli in the rat mouth flora was decreased and *B. lactic aerogenes* was observed more frequently.

39. PENICILLIN SENSITIVITY OF STREPTOCOCCI ISOLATED FROM ROOT CANAL INFECTIONS, OTHER MOUTH INFECTIONS AND THE NORMAL MOUTH. *Mary C. Crowley, M.S.P.H., and Verna Harner, B.S., School of Dentistry, University of Michigan, Ann Arbor, Mich.* Penicillin sensitivity tests were made on streptococci isolated from the normal mouth, infected root canals and a few other types of mouth infections. Tests were made in either beef infusion broth or tryphose broth containing 0.2% glucose and 5% ascitic fluid. 0.03 U, 0.5 U and 8.0 U of penicillin per c.c. of broth in 3 separate tubes were inoculated with equal amounts of a 24 hour broth culture of the organism being tested. Negative and positive controls were also made. Results varied within the different groups of streptococci. When penicillin is being used to treat infections, it is advisable to isolate and test the responsible organism to determine its sensitivity to penicillin. The anhemolytic streptococci isolated from root canal infections as a group showed marked resistance to penicillin. (Published in *J. D. Res.*, **26**: 399, 1947.)

40. CLINICAL EFFECT OF PENICILLIN IN ROOT CANAL AND PERIAPICAL INFECTIONS. *Floyd D. Ostrander, D.D.S., M.S., Mary C. Crowley, M.S.P.H. and John Dowson, D.D.S., School of Dentistry, University of Michigan, Ann Arbor, Mich.* Several papers have recently appeared in the literature reporting varying degrees of success in the treatment of root canal and periapical infections by the topical application of penicillin. The authors of this paper have used penicillin

experimentally in 3 ways: (1) In solution in physiologic salt solution, 5000 u. per c.c. (2) By means of absorbent points saturated with 1000 u. of penicillin. (3) By using a paste of penicillin and calcium carbonate made up with physiological salt solution. By the latter method it was possible to seal from 5000 to 10,000 U of penicillin into the tooth, depending on the size of the pulp chamber and by testing absorbent points removed from the tooth it was possible to demonstrate that the penicillin remained active at least 48 hours. While some infections yielded readily to penicillin, the overall results were less satisfactory than those obtained by standard methods of treatment. The anhemolytic streptococci were found to be particularly resistant to penicillin treatments. Furthermore, a close correlation was found between the clinical results and laboratory tests for penicillin sensitivity. (Published in *J. D. Res.*, **26**: 403, 1947.)

41. PENICILLIN BY LOCAL INJECTION. *Edward C. Dobbs, Dental School, University of Maryland, Baltimore, Md.* The use of penicillin by local injection in dental therapeutics is being investigated by using dental students and patients from the Dental School and University Hospital. By using a clinical approach, it is hoped to develop a satisfactory injection technic, indications and contraindications for use, vehicles of choice, and dosage requirements. The injection of solutions directly into inflamed and infected tissue is a procedure which was not accepted as good therapy. Whether the addition of an antibiotic agent to the injected solution will change the concensus on this procedure, time and experimentation only will tell. The combination of local anesthetic solutions with penicillin salts have been found useful and safe for producing anesthesia in fractures, extractions with local pericemental involvement, acute and chronic, etc.

42. HALITOSIS: VARIATIONS IN MOUTH AND TOTAL BREATH ODOR INTENSITY RESULTING FROM PROPHYLAXIS AND ANTISEPSIS. *L. W. O'Brien, P. P. Morris and R. R. Read, Washington University School of Dentistry and Lambert Pharmacal Company, St. Louis, Mo.* Osmoscope studies on a large group of individuals indicate that saliva putrifies rapidly on stagnation, oral prophylaxis reduces mouth and breath odors, tongue prophylaxis reduces mouth and breath odors, use of a dentifrice lowers mouth and breath odors somewhat transiently, antiseptic mouth rinse reduces and maintains for more than 3 hours low mouth and breath odors but water mouth rinse is ineffective. Antiseptic mouth rinse had no effect on odors of systemic origin such as from eating garlic. The reduction of mouth and breath odors by antiseptic mouth rinse appears to last sufficiently long to make it of value to the individual.

43. A METHOD OF MACHINE TABULATION OF DENTAL EXAMINATIONS USING AN INDIVIDUAL PUNCH CARD FOR EACH TOOTH. *Martha Howard Fales, Massachusetts Department of Health, Boston, Mass.* A method of machine tabulation of dental examinations using an individual punch card for each tooth has been used to analyze data from topical fluorine applications studies, mouthwash studies, and the basic data dental studies of the Division of Dental Health of the Massachusetts Department of Public Health, and a basic data study of 7.373 Michigan

children of the Michigan Department of Health, Bureau of Public Health Dentistry. The findings of the clinical dental examinations are transferred directly to punch cards with no preliminary computations. One card is used for each tooth. All conditions of individual tooth surfaces noted in the clinical dental examination can be coded on one card, leaving extra space for additional information. The individual tooth cards are run through an alphabetic accounting machine with a reproducing summary punch attached. This process yields one summary card for each case automatically punched from machine totals of individual tooth cards. As many totals as are desired may be obtained by wiring the machine for totals on specific data columns. To obtain grand totals for a study the summary cards are totalled by the alphabetic accounting machine. For studies of individual teeth, tooth surfaces, or quadrants the individual tooth cards are tabulated by the accounting machine. In all processing of data the chance of human error is cut to a minimum as all tabulations are made by machine with sufficient cross checks to verify machine function. Individual tooth cards allow great flexibility for subsequent analysis of data. The incidence of new dental caries in subsequent examinations on study groups may be obtained rapidly by use of a collator which compares 2 sets of individual tooth cards mechanically at a rate of 1,000 pairs of cards per hour.

44. DENSITY DISTRIBUTION OF RAT MOLAR ENAMEL. *J. Edward Gilda, D.D.S., School of Medicine and Dentistry, University of Rochester, Rochester, N. Y.* A modified Manly-Hodge technic was used. Short centrifuge tubes were fitted with ground glass stoppers to permit powder-weight determinations without sample transfer. A single sample of pooled, rat molar enamel, consisting of 12% junction particles and 88% enamel particles by weight, was separated successively at different densities over the range of 2.720 to 2.920. After each separation, the weight of enamel sinking and of enamel floating was determined. Since loss during the procedure was negligible, the 2 values were added and the fraction floating expressed as a percentage of the mean. Values for fraction floating were plotted against density and a smooth curve drawn through the points. The percentage of sample in each density interval of 0.02 over the range studied was derived from the curve. Beginning at d = 2.720 the values are: 1.4, 1.9, 2.6, 3.5, 4.8, 6.3, 9.1, 13.9, 29.4 and 26.9. The distribution curve of human enamel is quite different; only a small percentage of human enamel is 2.92 gm/cm^3 or less in density.

45. THE PERIODONTIUM OF THE SYRIAN HAMSTER. *David F. Mitchell, B.S., D.D.S., School of Medicine and Dentistry, University of Rochester, Rochester, N. Y.* Gross and histologic studies of the periodontium of the Syrian hamster have been made, and periodontal pocket formation was observed. Thirteen females and 12 males born and raised under controlled conditions and of known litter-mate distribution were killed, 5 each month, over a 5 month period. Histologic findings in the periodontium are described. A current study of hypothyroidism in the hamster, induced by the administration of 6-propyl thiouracil is discussed, and preliminary observations are reported.

46. ORAL CONDITIONS IN WORKERS CHRONICALLY EXPOSED TO DILUTE AND ANHYDROUS HYDROFLUORIC ACID.* *Peter P. Dale, A.B., D.M.D., and H. B. McCauley, D.D.S., University of Rochester School of Medicine and Dentistry, Rochester, N. Y.* To ascertain whether chronic exposures to atmospheric fluorides could produce oral changes, a dental survey was conducted among 35 men actively engaged in the production of hydrofluoric acid for 2 to 33 years, and 11 control subjects employed in sections of the plant removed from direct contact of the acid fumes. Oral conditions were established from detailed histories, oculo-instrumental examinations, complete periapical and bite-wing radiographs, and fluoride urinalyses obtained from spot urine samples. The HF workers revealed a significant decrease in number of carious lesions and in total surfaces involved by fillings and cavities, and an increase in the number of arrested cavities. Exposed persons gave mean values of 2.6 $\pm$ 3.2 for total cavities, 8.4 for surfaces involved by cavities and restorations, and 1.5 $\pm$ 1.8 for arrested lesions; whereas, the controls yielded respective values of 4.8 $\pm$ 2.6, 26.0 and 0.3 $\pm$ 0.5. Radiographic studies disclosed a change in the trabecular pattern of the osseous structures of the maxilla and mandible in 13 out of 15 workers exposed 10 years or more, and 10 out of 20 employed less than 10 years. The bone changes were characterized by an increase in the number and thickness of trabeculation per se and a corresponding reduction of the intratrabecular spaces. In no instance was evidence of sclerosis or general bone pathosis encountered. The men appeared unusually healthful and comparatively immune to colds, infections and commonplace illnesses. The fluoride excretion of 34 HF workers varied considerably, about a mean of 10.78 (plus or minus 9.3) mg. F per liter urine, and contrasts with the F output of 0.67 (plus or minus 0.63) mg. F per liter for 7 unexposed men. On the basis of this single urinalysis there was no apparent correlation with age of the employee, years of exposure to hydrofluoric acid, radiographic bone change or urinary fluoride excretion.

47. THE EFFECT OF VARIOUS CHEMICALS AND AMINO ACIDS ON THE RATE OF ACID FORMATION IN SALIVA. *L. S. Fosdick, Ph.D. and J. C. Calandra, Ph.D., Northwestern University School of Dentistry, Chicago, Ill.* A number of chemicals, including various quinones, hydroquinones, organic peroxides, aldehydes, and guanidine derivatives were tested for enzyme inhibiting action in saliva-glucose-enamel mixtures. It was found that most of the organic peroxides, quinones and hydroquinones were very active enzyme inhibitors. The guanidine and guanidine derivatives had no inhibitory action, while the aldehydes had a mild inhibitory action.

The effect of 17 different amino acids on the rate of acid formation in saliva-glucose-enamel mixtures was studied. It was found that valine, norleucine, phenylalanine and threonine had an appreciable enzyme inhibiting action, while hydroxyproline, tryptophane and isoleucine had a very mild effect. The other amino acids had no effect. The enzyme inhibiting activity bears no relation to

* This document is based on work performed under contract No. W.-7401-eng.-49 for The Manhattan Project at the University of Rochester.

the rate of deaminization of these acids under the conditions used. (Published in *J. D. Res.*, **26**: 303 and 309, 1947.)

48. TRISTIMULUS PHOTOLECTRIC COLORIMETRY OF HUMAN INCISORS. *R. S. Manly, Ph.D., Tufts College Dental School, Boston, Mass.* An apparatus for photo-electric measurement of color by the tristimulus method has been modified in order to permit readings to be taken on human upper first incisors in situ. The precision of measurement has been determined and results compared with visual matching of the same teeth with shade guides. Measurements have been made on upper first incisors of groups of clinic patients in order to furnish data on the question of whether teeth of older persons differ in color from those of younger patients.

49. RECENT DETERMINATIONS OF FLUORINE IN FOODS, BONES AND TEETH FOR A DENTAL CARIES STUDY. *D. J. Martin, Evanston Health Department, Evanston, Ill.* This is the preliminary report of the biological findings of the Dental Caries Study, Evanston, Illinois. The problems being investigated are: the amounts of fluorine ingested from the diet; the fluorine content of dental tissue, bones (crest of ilium), and fetuses (femurs, mandible and maxilla, and tooth buds); control of 1 part per million of fluorine in the potable water supply. The foods analyzed were: soups, 0.4 ppm. F to 2.8 ppm. F; rice, 1.0–2.6 ppm. F; Pablum 11.2 ppm. F; Pabina, 5.3 ppm. F; Spry, 2.1 ppm. F; oatmeal, 1.4 ppm. F. The fluorine content of sound teeth varied from 0.0104% to 0.0287%; with an average of 0.0202%; for carious teeth it was 0.0045% F to 0.0270% F with an average of 0.0133% F. The bones contained an average of 0.0376% F. The average fluorine content of the fetuses was: l. & r. femur, 20 ppm; mandible & maxilla, 19 ppm; tooth buds, 12.5 ppm. No difficulties have been encountered in maintaining an equilibrium of 1 ppm. F in the potable water supply. (To be published in the *J. D. Res.*)

VII. FIFTH SESSION: AFTERNOON; JUNE 21; ABSTRACTS 50–60

50. THE PALATINE TORUS: ITS RELATIONSHIP TO AGE, SEX, RACE, DIET, DEGENERACY, SYSTEMIC DISEASE, DENTAL CONDITIONS, AND HYPEROSTOSES OF THE JAWS. *Gabriel Lasker, College of Medicine, Wayne University, Detroit, Mich.* Torus palatinus is a bony downgrowth in the midline of the hard palate. It may vary in size, shape or position. It has been associated with syphilis, tuberculosis, rickets, insanity, idiocy, and criminality, but further study supports none of these contentions. It certainly is more frequent in females, progresses with age, occurs, especially in certain population groups including Lapps, Eskimo, Aino, and Icelanders. The trait is of little direct clinical significance but may be confused with malignancy. Continuing growth may hamper the fitting of dentures, and in extreme cases the torus may interfere with speech. The etiology has been obscured by the fact that in most studies age, sex, and race have not been adequately controlled. Genetic factors are probably important for the trait is usually concorant in identical twins. Dietary factors may also play a part for the trait is more common in American-born Chinese than in Chinese born and reared in China. There is little apparent association with palate shape, oc-

clusion, attrition, caries or loss of teeth—at least if age is taken into account—but the presence of other bony growths of the jaws such as torus mandibularis and maxillary and mandibular alveolar hyperostoses are positively correlated. Growths resembling torus palatinus are found in macaques and baboons but not among great apes.

51. PHOSPHATE TRANSFER IN SCLEROSED DENTIN STUDIED BY MEANS OF RADIOACTIVE PHOSPHORUS. *Wah Leung, D.D.S. and J. Edward Gilda, D.D.S., School of Medicine and Dentistry, University of Rochester, Rochester, N. Y.* Labial and buccal Class V cavities were prepared in the canine and several of the premolar and molar teeth of a dog. Those of the right side (control) were filled immediately with zinc oxide-eugenol cement; those in corresponding teeth of the left side were not filled until 3½ months later. At this time approximately 125 microcaries of P^{32} as Na_2HPO_4 were injected intraperitoneally. After 24 hours, the animal was vivi-perfused with a modified Locké solution and the teeth removed. Labiolingual sections were prepared taking care to keep specimens dry at all times. Dead tracts were observed only in those cavities which had been exposed to the oral fluids. Radio-autographs were made on Eastman Type A Industrial x-ray film. No difference in P^{32} uptake could be demonstrated between sclerosed and normal dentin in any of the teeth, indicating no gross difference in permeability. This finding is not in agreement with the results of investigations in which methylene blue was employed as an indicator of permeability.

52. EXCHANGE OF CALCIUM AND PHOSPHORUS AS THE MECHANISM OF RADIOISOTOPE ADSORPTION OF BONES AND TEETH. *Marlene Falkenheim, W. F. Neuman and H. C. Hodge, School of Medicine and Dentistry, University of Rochester, Rochester, N. Y.* Powdered bone, dentin, enamel and a synthetic hydroxyl apatite have been exposed to $calcium_{45}$ and $phosphorus_{32}$ in solutions separately in vitro. Each calcium phosphate was found to adsorb Ca_{45} and P_{32} according to a somewhat complicated course of reaction. There was a rapid phase of adsorption lasting perhaps 4 hours in the case of calcium and at least that long in the case of phosphorus. This rapid adsorption is succeeded by a much slower process which appears to be increasing slowly and steadily even after 10-day exposures to the solutions. For both ions it is possible to calculate the percentage of calcium and of phosphorus, respectively, in each solid which enters into an exchange reaction with the ionic calcium and phosphorus. For both ions the exchangeable fraction is of the order of 20% to 25%. The adsorbed Ca_{45} and P_{32} may be desorbed in a fashion which strongly indicates the reversibility of the exchange processes.

53. HOW ABRASIVE NEED A DENTIFRICE BE? *Paul C. Kitchin and Hamilton B. G. Robinson, College of Dentistry, The Ohio State University, Columbus, Ohio.* Unfortunately, the non-abrasive liquid dentifrices fail to remove a dark stain pellicle from the teeth of some individuals. On the other hand, considerable damage can be done to exposed cementum of the teeth by abrasive-containing dentifrices. To determine the least amount of abrasive needed to overcome the deficiency of abrasive-free dentifrice, the abrasiveness of 20 consumer-available and experimental dentifrices was measured on tooth structure and the effectiveness in removing stain in vivo was studied for 17 of these dentifrices in comparison

with water. These tests indicate that any dentifrice abrasion in excess of ability to cut 1.0 mm. of dentin with 100,000 cross brushing strokes at 75 grams pressure results in unnecessary loss of tooth structure. Five of the 9 commercial dentifrices tested produced abrasion in excess of this figure. The amount of abrasive required to keep the teeth free of stained pellicle varies from individual to individual, depending on their staining tendencies. (To be published in *J. D. Res.*)

54. DIRECT THREE DIMENSIONAL OBSERVATIONS ON THE ORGANIC ELEMENTS OF MATURE HUMAN ENAMEL. *Reidar F. Sognnaes, L.D.S., M.S., Ph.D., Harvard School of Dental Medicine, Boston, Mass.* The organic elements of mature enamel have been isolated by a controlled, low-temperature decalcification-fixation technic. A 3 dimensional study under binocular microscope was followed by micro-dissection and preparation of smears, spreads and paraffin sections. The organic framework rests on a rigid basal membrane with which it is easily detached from the dentin of decalcified teeth. From this membrane the prisms form regularly spaced longitudinal wavy rows. From their 3 dimensional appearence the term "corrugated" enamel seems to cover adequately what in cross sections has been interpreted as individual "tufts" (central portion) and in longitudinal sections as "bands" of Schreger (cut wave-tops). The corrugated enamel is most prevalent in the internal part of bulky enamel. The Retzius striae and the neonatal lines are likewise recoverable in the organic framework, and represent a rythmic thickening of the prism sheaths. The organic nature of these various structures is demonstrated in completely decalcified enamel. When "naked" enamel surfaces of functioning teeth are exposed by attrition, cavities, fillings and cracks, they are covered by resistant organic membranes. In enamel caries these have a characteristic pattern, determined by the corrugation of the enamel and the extent of the external (plaque?) or internal disturbance of the normal relationship of the enamel to its surrounding environment. It is believed that these organic membranes (including the so-called lamellae) may be of a protective rather than destructive significance.

55. ENAMEL FORMATION IN AMELOBLASTOMAS (ADAMANTINOMAS). *Bernhard Gottlieb and R. Gordon Agnew, Dental School, Baylor University, Dallas, Tex.* In all publications relative to ameloblastomas, to date, it has been underlined that no enamel is formed in these tumors. We have found a number of tumors of this type in which enamel formation may be demonstrated. One tumor formed only homogeneous enamel matrix without prism differentiation. A large number of such masses of enamel matrix were examined and, in no instance could a trace of prism differentiation be found. In some cases a lightening of the otherwise darkly staining areas of matrix indicated some degree of maturation. Nowhere could a stratum intermedium be identified. In another group of tumors areas of enamel were observed in which portions remained in the homogeneous stage while other portions showed distinct prism differentiation. In these tumors a stratum intermedium was demonstrable. This may point to the possibility that the function of the stratum intermedium is somehow connected with the process of prism differentiation.

In some of the tumors, i.e. those which showed the formation of large numbers

of enamel matrix areas, bone formation was conspicuous by its very poor calcification. It may be that the enzymes which are needed for the calcification of bone were tied with the process of enamel formation in such a way that an insufficiency was left for the process of bone calcification.

56. OBSERVATIONS ON ENAMEL FORMATION. *R. Gordon Agnew, M.Sc., D.D.S., Ph.D., West China Union University, Chengtu, China.* Certain observable phenomena in amelogenesis present difficulties of compatibility with current concepts, for example, that of harmonizing prism distribution and direction, in many instances, with the principle of structural dependence upon a corresponding ameloblast. Gottlieb has suggested that prism differentiation develops from a homogeneous matrix stage without dependence upon ameloblasts, a process comparable to crystal formation from a hypersaturated salt solution. This strictly preliminary report (part of larger investigation) concerns developmental aspects in several kinds of animals relative to above problems. Even in rapid enamel formation in continuously growing teeth, there is commonly a stage in which a seemingly homogeneous matrix appears to intervene before final prism differentiation. In the rabbit, the width of the bands in the incisor, formed by differentiated and seemingly non-differentiated matrix areas, constitute a quantitative pattern harmonizing with the chronological sequence. In the rat incisor, the 'homogeneous' band appears widespread under routine staining, less so under Mallory-Azan. Rod directions are relatively uncomplicated. A related problem concerns the nature of the so-called fibrous enamel of Owen. Observations on other animals suggest that the prism course, in differentiated stages, may raise serious question concerning the concept of the rod as a continuation of the functional course of the ameloblast. (Cf. also certain areas of human enamel.) In the sheep, prisms are observed running parallel to the surface, i.e. perpendicular to the ameloblast course. In the lagostomus (hare), the seemingly homogeneous enamel matrix so differentiates that bands of horizontally directed prisms uniformly alternate with perpendicularly directed bands. Such a pattern seems to stand in no essential relationship to the ameloblast course.

57. SERIAL ROENTGENOGRAPHIC METHODS APPLIED TO STUDIES OF GROWTH IN SMALL LABORATORY ANIMALS. *W. W. Wainwright, D.D.S., M.S., University of Rochester School of Medicine and Dentistry, Rochester, N. Y.* The need for sacrificing an experimental animal in order to measure dental and osseous growth may be avoided by use of serial roentgenograms of living animals. The following are paramount: 1. *Contrast:* Usual dental or no screen film is not suitable for roentgenograms of bones and teeth of small laboratory animals. Greater contrast and finer grain size are provided by industrial type x-ray films (such as Kodak Industrial X-ray Film Type A) which may be developed in standard x-ray developers. Contrast may be increased by increasing developing time and by reducing kilovoltage to 40 or below if suitable adjustment is made in film wrapper. 2. *Time of Exposure:* Industrial films require longer exposure but this can be overcome by increasing milliamperage through use of rotating anode tube and by increasing developing time. 3. *Anesthesia:* Dental growth may be studied by the methods of Jarabac (*Angle Orthodontist* **12:** 87, 1942) and Spence (*Ibid.*

10: 127, 1940) which require that animal be anesthetized. The tibia can be roentgenographed serially *without necessity* of anesthesia by method of O'Brien and Morgareidge (*J. Nutrition* **16:** 91, 1938). 4. *Special Apparatus:* By placing lead mask with central rectangular opening on standard open cone of medical type tube requirements of O'Brien and Morgareidge can be met without specially constructed apparatus. 5. *Scattered Radiation:* Animal, if held by hand, must be arranged so that operator at no time works in path of direct beam. Even outside of direct beam dangerous amounts of radiation may be reflected from animal to nearby operator when repeated exposures are made. This scattered radiation must be measured for specific apparatus and conditions of use. Measurements of scatter should not be estimated solely from effects on dental pack film (Frank W. Dreisinger, Unpublished data). Under suitable conditions scatter may be measured with instruments such as Victorine pencil chambers in conjunction with a Minometer within their range of sensitivity and accuracy.

58. CEMENTICLES AND OTHER HARD STRUCTURES IN THE PERIODONTAL MEMBRANE. *O. J. Mikola, D.D.S., and Wm. H. Bauer, M.D.,D.D.S., Saint Louis University, School of Dentistry, St. Louis, Mo.* Studies of microscopic sections obtained from human jaws provided reliable source of information as to pathogenesis of cementicles and other hard structures in the periodontal membrane. Cementicles, which are originally free spherical bodies in periodontal membrane, may become included within cementum or alveolar bone plate, or may even be seen in the bone marrow on tension side of drifting or moved teeth. Cementicles take their origin most commonly from degenerating epithelial rests of Malassez; less frequently from thrombosed veins of the periodontal membrane or calcified minute hemorrhages. Dystrophic calcification always precedes this type of cementicle formation. Also, cementicles may have their origin in fragments of the cementum or alveolar plate that have been traumatically detached into the periodontal membrane and modeled into round bodies by the physiological movements of the tooth in its socket. The histological characteristics of cementicles may be that of primary cementum or they may be that of a homogenously calcified mass which is occasionally coated by bone tissue. Osteoclastic resorption and fractures of cementicles are frequently observed. In addition to cementicles, splinters of cementum or alveolar bone, traumatically displaced into the periodontal membrane and eventually united by soft or hard callus to the cementum or alveolar bone, are seen. These splinters or fragments also may remain within the periodontal membrane attached to both the root surface and alveolar bone by newly formed periodontal tissue.

59. FIBROUS OSTEOMA, CEMENTOBLASTOMA AND HYPEROSTOSIS OF THE JAWS. *J. A. McBrien, D.D.S. and Wm. H. Bauer, M.D.,D.D.S., St. Louis University, School of Dentistry, St. Louis, Mo.* Microscopic studies supported by roentgenographic examination reveal an interesting resemblance between the pathogenesis and the degrees of maturation of the fibrous osteoma and cementoblastoma of the jaws. The fibrous osteoma which occurs as a fairly well demarcated or diffuse swelling in the skull, but mainly in the jaws, must not be confused with the ossifying fibroma of soft tissue. The cementoblastoma is more common in

the mandible than in the maxilla and is a more or less sharply bordered growth. Both types of tumors have ground substance of connective tissue. In the fibrous osteoma the originally vascular connective tissue first forms spicules of an osteoid substance which gradually undergoes an irregular spotty calcification while vascularity and cellularity decrease. Eventually an osteoma develops. In the cementoblastoma the same type of vascular connective tissue produces more or less roundish bodies of a cementoid tissue which gradually becomes irregularly calcified to finally result into a cementoma. The hyperostosis of the jaws is of inflammatory origin. Numerous sections taken from different depths of the specimen are necessary to prove the inflammatory nature.

60. HEALING OF EXPOSURES IN CARIES EXPOSED PULPS. *A. P. Lund, D.D.S., Ph.D., School of Dentistry, University of Minnesota, Minneapolis, Minn.* A procedure for treating carious exposures, healing the exposure and preserving the vital pulp are described. Directions are given for the preparation and sterilization of cavity together with the preparation and installation of a medicated pack. The function of the medicated pack is to maintain the cavity health, soothe pain and stimulate the deposition of secondary dentin. After several months the medicated pack is removed, the extent of the deposit of secondary dentin is recorded by x-ray, then the dental drill is used to finish the cavity preparation, polish all the cavity walls to remove any unsound dentin, repeat using a second medicated pack if the cavity is very sensitive, if not sensitive, proceed with the insertion of the cement base and the filling in the usual way.

VIII. ANNUAL DINNER AND SIXTH SESSION: EVENING; JUNE 22

61. INDUCTION OF GENERAL OFFICERS FOR 1947–48 AND REMARKS OF RETIRING PRESIDENT. *Samuel W. Chase, Ph.D., Western Reserve University, Cleveland, Ohio.*

62. INAUGURAL ADDRESS: IMPRESSIONS OF OPERATION CROSSROADS. *Harold C. Hodge, Ph.D., University of Rochester, Rochester, N. Y.* (*See p. 485.*)

IX. MATERIALS GROUP: THE FOLLOWING PAPERS WERE PRESENTED IN THREE SESSIONS HELD ON JUNE 21, TITLES 1–14

1. THE USE OF SPECIFICATIONS IN THE PROCUREMENT OF NAVAL DENTAL STORES DURING WORLD WAR II. *G. C. Paffenbarger, National Bureau of Standards, Washington, D. C.*

2. HOW DENTAL SPECIFICATIONS SERVED THE ARMY IN PROCUREMENT DURING WORLD WAR II. *P. B. Taylor, Julius Aderer, Inc.*

3. A PRELIMINARY REPORT ON THE TESTING OF DENTAL BURS. *R. L. Lasater, Northwestern University, Chicago, Illinois.*

4. TEACHING MATERIALS FROM THE VIEWPOINT OF A MEMBER OF THE NATIONAL BOARD OF DENTAL EXAMINERS. *W. H. Crawford, University of Minnesota, Minneapolis, Minnesota.*

5. THE RELATIVE MERITS OF VACUUM INVESTING AND CONVENTIONAL INVESTING. *R. W. Phillips, Indiana University, Indianapolis, Indiana.*

6. EFFECT OF MOLD TEMPERATURE ON PHYSICAL PROPERTIES OF CASTING GOLDS. *P. B. Taylor, Julius Aderer, Inc.*

7. OCCASIONAL DISCOLORATION OF HIGH PRECISION PRECIOUS METAL CASTINGS. *R. C. Brumfield and C. E. Horner, J. L. Jelenko Co.*

8. SUPPLEMENTING TESTS ON DENTAL GOLDS. *John S. Shell, Thomas Dee and Co.*

9. SURFACE PHENOMENA OF DENTAL CASTINGS. *C. E. Pomes, Northwestern University, Chicago, Illinois.*

10. DANGER IN USE OF TIN FOIL SUBSTITUTES. *G. W. Ferguson.*

11. ACRYLIC CLINICAL OBSERVATIONS. *Douglas H. Yock, University of Minnesota, Minneapolis, Minnesota.*

12. THE DIMENSIONAL STABILITY OF SMALL CYLINDERS OF ACRYLIC RESIN. *E. W. Skinner and Gustav Dahl, Northwestern University, Chicago, Illinois.*

13. PROCESSING DENTAL RESINS BY DRY THERMAL METHODS. *F. A. Peyton, University of Texas, Houston, Texas.*

14. A METHOD FOR THE QUANTITATIVE DETERMINATION OF THE DEGREE OF POLYMERIZATION OF ACRYLIC RESIN. *H. J. Caul, National Bureau of Standards, Washington, D. C.*

X. ABSTRACTS OF PAPERS READ BY TITLE: ABSTRACTS 61–87

61. OSSIFICATION AT THE DISTAL END OF THE HUMERUS IN THE FEMALE RAT. II. CHANGES AT PROGRESSIVELY LONGER INTERVALS FOLLOWING HYPOPHYSECTOMY. *C. Willet Asling, M.D., Hermann Becks, M.D., D.D.S., Miriam E. Simpson, Ph.D., M.D., and Herbert M. Evans, M.D., College of Dentistry, Institute of Experimental Biology, George Williams Hooper Foundation for Medical Research, University of California, San Francisco and Berkeley, Cal.* Fifty-five female rats of the Long-Evans strain were hypophysectomized at 25–30 days of age. The distal epiphysis of the humerus was examined at post-operative intervals ranging from 4 to 444 days. The evanescence of the cartilage plate associated with the main epiphyseal ossification center rendered it unsuited for study of the effects of hypophysectomy. The cartilage plate of the secondary ossification center in the medial epicondyle, however, underwent regressive changes which could be seen as early as the fourth post-operative day. Chondrogenesis slowed, capillary penetration of the cartilage ceased, and a progressively thicker layer of bone (terminal plate) formed on the juxta-medullary surface of the epiphyseal cartilage, sealing it from the marrow. This atrophic, sealed-off cartilage plate persisted past the usual age of epiphyseal closure (102–135 days of age) and was present in the most advanced post-operative periods studied (444 days), fully a year after closure would have taken place in normal rats.

62. OSSIFICATION AT THE DISTAL END OF THE HUMERUS IN THE FEMALE RAT. I. CHANGES WITH INCREASING AGE. *C. Willet Asling, M.D., Hermann Becks, M.D., D.D.S., Miriam E. Simpson, Ph.D., M.D., and Herbert M. Evans, M.D., College of Dentistry, Institute of Experimental Biology, George Williams Hooper Foundation for Medical Research, University of California, San Francisco and Berkeley Cal.* In a search for suitable sites for study of endocrine control of

epiphyseal union in the rat, the distal epiphysis of the humerus was selected as a possibility on the basis of its reported early closure. Standards of age changes and reference plane of section were established by histologic study of the humeri of 84 normal female rats of the Long-Evans strain, between 10 and 449 days of age. The reference plane chosen passed through the shaft, olecranon fossa, both epicondyles, and the articular fossa; it permitted examination of the main epiphyseal ossification center, the secondary center in the medial epicondyle, and the associated epiphyseal cartilage plates. The main center appears at 15 days of age in the cartilaginous epiphysis; by 20 days of age its expansion reduces the cartilage to an epiphyseal plate connecting the two epicondyles. This cartilage plate is rapidly perforated and reduced to fragments, and epiphysio-diaphyseal union is complete by 40 days of age. The secondary ossification center in the medial epicondyle is established between 20 and 25 days of age; its activity continues undiminished until 75 days of age. Its epiphyseal cartilage plate may disappear as early as 102 days or as late as 135 days of age; no traces of it were found after 160 days of age. The tilted plane of this plate may make the preparation of serial sections necessary for accurate interpretation of results.

63. GIGANTISM PRODUCED IN NORMAL FEMALE RATS BY CHRONIC TREATMENT WITH PURE PITUITARY GROWTH HORMONE. I. SKELETAL CHANGES: SKULL AND DENTITION. *Hermann Becks, M.D., D.D.S., Daniel A. Collins, M.S., D.D.S., C. Willet Asling, M.A., M.D., Miriam E. Simpson, Ph.D., M.D., and Herbert M. Evans, M.D., College of Dentistry, Institute of Experimental Biology, George Williams Hooper Foundation for Medical Research, University of California, San Francisco and Berkeley, Cal.* Gigantism was induced in 8 normal female rats by daily injection of pituitary growth hormone for 437 days, after their growth curves had plateaued. Their skeletons were examined roentgenographically and histologically, and compared with those of 5 normal controls. Roentgenographic analysis showed that following the injections the skull and dentition (incisors and molars) were decidedly larger. Bone structure was markedly denser; the sinuses were increased in size. Skull measurements on the roentgenograms showed that the lower jaw had undergone a proportionately greater growth than did the upper jaw, both in horizontal and vertical dimensions. Histologic examination of the mandibular articulation showed continued osteogenesis with resultant hyperossification, exostoses, and distortion of the form of the neck and head of the condyle. Similar activity was elicited in the glenoid fossa. The teeth were larger; the incisors showed numerous areas of interglobular dentin, while the molars showed larger and longer roots and an unusual degree of hypercementosis. The bone supporting the molars was extremely dense, and only small islets of marrow tissue could be seen. Intramembranous ossification was stimulated, as shown by lines of accretion at the sagittal suture as well as on inner and other tables of the parietal bones. These findings in the normal adult rat following chronic injection with the pure pituitary growth hormone are similar to those described as typical for acromegaly in the human.

64. OSSIFICATION AT THE DISTAL END OF THE HUMERUS IN THE FEMALE RAT. III. RESPONSE TO PITUITARY GROWTH HORMONE AND THYROXIN AFTER HYPO-

PHYSECTOMY. *Hermann Becks, M.D., D.D.S., C. Willet Asling, M.D., Miriam E. Simpson, Ph.D., M.D., and Herbert M. Evans, M.D., College of Dentistry, Institute of Experimental Biology, George Williams Hooper Foundation for Medical Research, University of California, San Francisco and Berkeley, Cal.* Thirty-seven female rats of the Long-Evans strain, hypophysectomized at 26 to 30 days of age, were maintained for long postoperative intervals (283–502 days). They were divided into 4 groups: the first served as control, the second received injections of pure pituitary growth hormone, the third received thyroxin, and the fourth received the combination of growth hormone and thyroxin. The injection period was 39 days. The response of the epiphyseal ossification center in the medial epicondyle of the humerus was studied histologically. The epiphyseal cartilage plate of the hypophysectomized controls was persistent, atrophic, and sealed off by bone from the marrow cavity. In rats receiving growth hormone chondrogenesis and osteogenesis were reactivated and the sealing-off bone was broken up. Of the animals receiving thyroxin alone, half showed breaking-up of the sealing-off bone and capillary penetration of the epiphyseal cartilage, without stimulation of chondrogenesis. In the other half of this group, this process had been carried further, with complete disappearance of the cartilage plate and closure of the ossification center. In rats receiving both growth hormone and thyroxin, the response of the cartilage was augmented; the cartilage plate was maintained and the growth of the epicondyle increased. The closure of an epiphysis reported here following administration of thyroxin to the hypophysectomized rat cannot be due to indirect stimulation of the pituitary gland by thyroid hormone and must be direct.

65. OSSIFICATION AT THE DISTAL END OF THE METACARPAL IN THE FEMALE RAT. III. RESPONSE TO PITUITARY GROWTH HORMONE AND THYROXIN AFTER HYPOPHYSECTOMY. *Hermann Becks, M.D., D.D.S., Daniel A. Collins, M.S., D.D.S., Miriam E. Simpson, Ph.D., M.D., and Herbert M. Evans, M.D., College of Dentistry, Institute of Experimental Biology, George Williams Hooper Foundation for Medical Research, University of California, San Francisco and Berkeley, Cal.* Thirty-seven female rats of the Long-Evans strain were hypophysectomized at 26 to 30 days of age and maintained for long post-operative intervals (283–502 days). They were divided into 4 groups; the first were hypophysectomized controls; the second received pure pituitary growth hormone; the third received thyroxin; and the fourth received growth hormone and thyroxin in combination. The hormones were injected daily for 39 days. The distal end of the third metacarpal was studied histologically. In the control group the epiphyseal cartilage was present, although atrophic, and sealed off by layers of bone on the diaphyseal and epiphyseal surfaces. The group receiving growth hormone showed a reactivation of osteogenesis and chondrogenesis; the sealing off bone on the diaphyseal side was broken up and marrow elements reached the cartilage between the bone fragments. A zonal arrangement of the cartilage plate and capillary erosion like that of the young, normal, growing rat was re-established. In the animals receiving thyroxin alone the cartilage plate was entirely absent, showing that complete cartilage resorption and epiphyseal closure had occurred during the

administration of thyroid hormone. In the group of rats receiving both growth hormone and thyroxin approximately one-half of the animals showed complete disappearance of the cartilage plate of the metacarpal and the other showed a cartilage width and activity somewhat less than that seen in the group receiving growth hormone alone.

66. CARCINOMA OF THE LIP. *Joseph L. Bernier, D.D.S., M.S., Army Institute of Pathology, Washington, D. C.* Analysis of approximately 1000 cases of carcinoma of the lip occurring in members of the Armed Forces indicates that these tumors may occur in a somewhat younger age group than heretofore thought. In this survey, approximately 40% occurred between 30 and 40 years of age. Clinically, 2 types can be recognized, a papillomatous form which has a longer clinical course and is, as a rule, less malignant than the verrucal form. Of the exogenous factors, the use of tobacco is of unquestioned importance as an etiologic agent. In addition, actinic irradiation, extreme cold, dust and wind are also important factors. These lesions, if seen early in their course and treated adequately by either surgery, radiation or both, have a good prognosis. Histologic classification of lip carcinomas closely parallels the clinical division mentioned. It is often possible to more accurately predict their course on the basis of careful clinical analysis than on morphologic study. This is because of the greater number of borderline lesions which defy accurate histologic classification. The term "leukoplakia" should be reserved for those lesions in which there is either hyperkeratosis, parakeratosis, or both, fusing of the rete, and dyskeratosis. Such a lesion is, in reality, carcinoma in situ and, as such, must be treated more drastically than the benign keratoses.

67. THE REPAIR OF GINGIVAL TISSUE FOLLOWING SURGICAL REMOVAL. *Joseph L. Bernier, D.D.S., M.S., Army Institute of Pathology, and Harry Kaplan, D.D.S., Washington, D. C.* In this experiment, blocks of tissue containing 1 or more adjacent teeth were removed at varying intervals following gingivectomy. The repair of the granulation surface, as shown in this work, is greatly facilitated by the use of a pack which acts as a mild surface irritant, calling forth a cellular response of both the vascular and the fixed tissue elements. After from 8 to 10 days removal of the pack is indicated because, at this time, the gingival surface is completely covered by an actively proliferating epithelium. Although one should attempt to attain surgical asepsis, it is very likely that bacteriologic sterility is detrimental to the healing process. Since normal gingival tissue, in a great percentage of cases, is infiltrated with chronic inflammatory elements, and since such a reaction acts as a stimulating mechanism on the healing process, it is not essential that all such inflamed tissue be removed. (Published in J.A.D.A. **35**: 697, 1947).

68. CLINICAL STUDIES OF PITUITARY DWARFISM. *M. Michael Cohen, D.M.D. and Richard Wagner, M.D., Boston Floating Hospital, Tufts College Medical School and the Boston Dispensary, Boston, Mass.* Careful observations of dentition and jaw development were made on two individuals with pituitary dwarfism over a long period of time. Case I. Seen at 2 years, 9 months. Height: 29.8 inches. Wrist radiograph consistent with 9 months. At 4 years had 20 normal

deciduous teeth in good occlusion, permanent teeth calcifying according to chronological age of patient and jaws proportionate to skeleton. Observed and treated for 5 years. Teeth calcified normally but jaws did not grow spacially, retarded tooth eruption. Case II. Seen at 11 years, 9 months. Height: 44 inches. Wrist radiograph consistent with 4 years. Observed and treated 7¼ years. Dental examination at 15 years revealed 12 permanent and 2 deciduous maxillary teeth with irregular, crowded incisors, mandible and 12 permanent teeth erupted and although 2nd molars unerupted roots were almost completely formed. Ramus of mandible undeveloped holding 2nd molars. Apparently in pituitary dwarfism, jaws do not grow spacially and although teeth develop and calcify normally, the bone growth delay retards eruption.

69. OSSIFICATION OF THE DISTAL END OF THE METACARPAL IN THE FEMALE RAT. I. CHANGES WITH INCREASING AGE. *Daniel A. Collins, M.S., D.D.S., Hermann Becks, M.D., D.D.S., Miriam E. Simpson, Ph.D., M.D., and Herbert M. Evans, M.D., College of Dentistry, Institute of Experimental Biology, George Williams Hooper Foundation for Medical Research, University of California, San Francisco and Berkeley, Cal.* The metacarpal bone of the rat was selected as a possibility for study in the search for an epiphyses characterized by an early age of closure. From the standpoints of simplicity and rapidity of histologic preparation, ease of orientation, and relatively slight variation in normal age of closure it was found well-suited for use in endocrine experiments on skeletal development. The third metacarpal was chosen on the basis of its importance as an axial bone throughout vertebrate history. Its ossification, maturation and senescence were studied histologically in 60 normal female rats of the Long-Evans strain, between the ages of 5 and 1316 days. At 5 days of age, the primary center of ossification is near the center of the shaft; the entire distal end of the bone is cartilaginous. At 15 days a secondary center of ossification appears in this distal cartilage thus establishing the epiphysis and the diaphysis. By 28 days expansion of the secondary ossification center has reduced the cartilage plate to the width characteristic of the growing rat from 28 to 75 days of age. At 75 days of age chondrogenesis has almost ceased; new trabecular formation is not seen after this age. At 90 days of age resorption of the cartilage is more active and by 102 days of age multiple perforations of the epiphyseal cartilage persists. By 110 days of age only fragments of the cartilage remain in some animals. Continued resorption in this region results in removal of all cartilage and bone so that by 250 days of age no evidence of this tissue is seen. No further significant changes were observed up to 1316 days of age.

70. OSSIFICATION AT THE DISTAL END OF THE METACARPAL IN THE FEMALE RAT. II. CHANGES AT PROGRESSIVELY LONG INTERVALS FOLLOWING HYPOPHYSECTOMY. *Daniel A. Collins, M.S., D.D.S., Hermann Becks, M.D., D.D.S., Miriam E. Simpson, Ph.D., M.D., and Herbert M. Evans, M.D., College of Dentistry, Institute of Experimental Biology, George Williams Hooper Foundation for Medical Research, University of California, San Francisco, and Berkeley, California.* Fifty female rats of the Long-Evans strain were hypophysectomized at 25 to 30 days of age. The distal end of the 3rd metacarpal was examined histologically at

intervals ranging from 4 to 639 days after the operation to determine the effect of hypophysectomy on closure of this epiphysis. At 8 days after the operation, chondrogenesis and formation of trabecular bone were severely reduced and the epiphyseal cartilage resembled that of a 75 day old normal rat. With longer postoperative intervals there is progressive slowing of chondrogenesis, decrease in size and number of chondrocytes, basophilia of the juxta-medullary region of the epiphyseal cartilage, and formation of a layer of bone on both the epiphyseal and diaphyseal surfaces of the epiphyseal cartilage plate. This intact atrophic sealed-off epiphyseal cartilage plate persisted past the usual age of closure for the metacarpal (102–110 days of age) and was still present 639 days after hypophysectomy, the longest postoperative interval studied.

71. GIGANTISM PRODUCED IN NORMAL FEMALE RATS BY CHRONIC TREATMENT WITH PURE PITUITARY GROWTH HORMONE. II. SKELETAL CHANGES; TIBIA, COSTOCHONDRAL JUNCTION, AND CAUDAL VERTEBRAE. *Herbert M. Evans, M.D., Hermann Becks, M.D., D.D.S., C. Willet Asling, M.A., M.D., and C. H. Li, Ph.D., Institute of Experimental Biology, College of Dentistry, George Williams Hooper Foundation for Medical Research, University of California, Berkeley and San Francisco, California.* Gigantism was induced in eight normal adult female rats by pituitary growth hormone. Five normal rats served as controls. Linear increase in the bones measured was proportional to that of the entire body. The average length of tibias was 44.6 mm. for injected rats, and 39.7 mm. for controls. Caudal vertebrae increased in length, the 9th segment measuring 10.6 mm. in injected rats and 9.4 mm. in controls. Metacarpal and metatarsal maturation had occurred before onset of injections, and overgrowth of paws was not seen. Endochondral ossification was studied at the proximal end of the tibia, at the costochondral junction, and in caudal vertebrae. Injected rats had an average tibial epiphyseal cartilage width of 154 μ, compared with 126 μ in controls. In all epiphyses examined there was persistence of some zonal arrangement in the cartilage, erosion of cartilage at point of contact with capillary tufts, and formation of delicate trabecular bone, indicating continuing chondrogenesis and osteogenesis. Controls showed atrophic cartilage subject to little or no erosion; capillary tufts were rare; bone trabeculae were coarse and few in number.

72. HISTOPATHOLOGY OF THE CARIOUS LESION IN THE MOLAR TEETH OF THE SYRIAN HAMSTER. *Harry E. Frisbie and James Nuckolls, University of California, College of Dentistry, San Francisco, Cal.* A preliminary study of the character and distribution of carious lesions in molar teeth of the Syrian hamster was done on animals living in optimal laboratory conditions. Teeth which showed an intact, discolored area were fixed, demineralized, and the recovered matrix was serially sectioned to the order of 4 μ. A microscopic study of the carious tracts revealed bacteria penetrating along confined channels to the dentino-enamel junction and there establishing a focus of the infection. These organisms appear morphologically to be of a spheroidal type similar to those observed by Keyes (*J. D. Res.* **25**: 341, 1946). The smooth surface lesion has its initiation in the remnants of the organic secondary cuticle which remains adherent to the enamel in protected areas of the teeth. The beginning of the smooth surface lesion is

identical to that observed in enamel fissures which contain remnants of the secondary cuticle.

73. PROPYL-THIOURACIL-HYPOTHYROIDISM IN THE ALBINO RAT—ITS EFFECT ON THE JAWS. *Irving Glickman and Samuel Pruzansky, Tufts College Dental School, Boston, Mass.* The effect of thyroid inhibition on the jaws of the albino rat was investigated using 6n-propyl-2-thiouracil. The drug was ground in with mink chow diet and fed at libidum, to 114 male and female rats (Hisaw) in two dosages of 0.1% and 0.03%. The animals were divided into 3 groups which received the drug as follows: 1. 1–5 days following birth via the transmammary route—65 rats. 2. At weaning (21–27 days after birth)—21 rats. 3. Young adults (3–5 months)—28 rats. The experiment was carried on with litter mate controls for a period varying from 1–3 months. Weight changes and general development were noted throughout the experimental period. At time of sacrifice, the weight, body and tail length, and appearance of the thyroid gland were recorded. The skull, jaws, ribs, vertebrae, and knee-joint were x-rayed. These tissues were studied microscopically. Observations on animals in group I receiving dosage 0.1% are reported. These animals weighed less, were smaller and retained relatively undeveloped bodily proportions. X-ray examination of the skeleton revealed comparatively early bone age. The jaws were smaller and showed retarded eruption of incisors and molars. Microscopic examination of the jaws revealed reduced endosteal and periosteal bone deposition throughout. The appositional bone lines were more closely arranged giving the bone a compressed appearance.

74. INFLUENCE OF VARIOUS LEVELS OF IRON ON DENTAL AND ADIPOSE TISSUES IN VITAMIN E DEFICIENT RATS. *Humberto Granados and Henrik Dam, Polytechnic Institute, Department of Biology, Copenhagen.* Two groups of newly weaned rats were reared for 126 days, one on an E-deficient diet (containing 20% cod liver oil) the salt mixture (U.S.P. XII) of which was modified so as to exclude Fe completely, and one on an E-deficient diet (containing 20% cod liver oil) the salt mixture (U.S.P. XII) of which was modified so as to increase its Fe content to 2.2%. Both groups exhibited from about the same time and to the same extent depigmentation of the upper incisors and yellow-brown coloration of the adipose tissue, comparable to such changes as were reported previously (*Science* **101**: 250, 1945) when fed a salt mixture (U.S.P. XII) containing 0.52% of Fe. These results show that different levels of dietary Fe do not modify under the established circumstances the changes produced by E-deficient diets containing 20% cod liver oil. The correlation of the anemia produced by 20% cod liver oil in both E-deficient and E-sufficient rats, without dental and adipose changes in the latter (*Acta Phys. Scand.* **10**: 162, 1945) with the present results indicates that in vitamin E deficiency dental depigmentation and brown coloration of adipose tissue depend on the presence of highly unsaturated fatty acids in absence of vitamin E in the ameloblasts and fat cells themselves rather than on the levels of dietary Fe or the Fe content of the blood. The fact that the normal incisor pigment contains mainly inorganic Fe in the ferric form (*Science* **102**: 327, 1945) suggests the possibility that in vitamin E deficiency the highly unsaturated fatty

acids induce a reduction of the ferric Fe in the ameloblasts into the ferrous form, preventing so the deposition of the ferric compound as a pigment.

75. LOCATION AND EXTENT OF ABRASION OF TEETH OF PRIMITIVE AMERICAN INDIANS. *E. H. Hatton, M.D., Northwestern University School of Dentistry, Chicago, Ill.* Indian skulls in the museums of Northwestern University and Chicago Natural History in most cases have extensive abrasions of the teeth, chiefly of occlusal surfaces. There are a few examples of inter-proximal wear but absolutely none of the surfaces adjacent to the gingival crest. This is not an original observation as W. D. Miller and others have reported much earlier to the same effect. The 54 skulls in the museum of the Northwestern University Dental School have a total of 1183 teeth of which 1114 have some degree of occlusal abrasion. These abrasions may be divided into: 1st degree, 331; 2nd degree, 352; 3rd degree, 307; and 4th degree (into pulp chamber) 125. Carious teeth numbered 84 or 7.1%. The skulls examined at the Chicago Museum of Natural History, including some from Pacific island aborigines, supplied no essentially different information. Specifically in these latter groups there is not a single example of gingival-crest level abrasion.

76. CARIES OF THE ENAMEL. A BACTERIOLOGICAL STUDY OF ACTINOMYCETES ASSOCIATED WITH THE DENTAL PLAQUE (PRELIMINARY REPORT). *Valerie Hurst, James Nuckolls and Harry E. Frisbie, University of California, College of Dentistry, San Francisco, Cal.* In histological sections of enamel matrix in which the bacterial plaque is retained in situ, filamentous organisms appear to form a dense mat on the surface of the enamel and to be intimately attached to the ends of the enamel rods. From scrapings of the plaque, microorganisms which resemble these filamentous forms morphologically may be cultivated. They develop on blood agar after incubation at 37° C. for 4 to 5 days. An atmosphere of about 10% carbon dioxide seems to favor primary isolation. Subsequently the organisms will grow on any of a variety of culture media. Fermentations of carbohydrates have been weak and slow with the several strains tested. Gelatin is not liquified; a dark pigment develops in about 1 to 2 weeks on this medium. These organisms are morphologically similar to the actinomycetes, a group that has been called simple molds or pleomorphic bacteria. They may easily be identical with the Leptothrix, Streptothrix, and Cladothrix described in the early dental literature under terms no longer used. Small forms, frequently associated with the filamentous form in a single colony, resemble diphtheroids and irregular cocci. After repeated subculture of some strains, these forms almost completely replace the filaments. The change in the form of the cells may be accompanied by a change in the appearance of the colony. Neither the age of the culture, nor the kind of media has thus far been associated with the changes in the cells. These organisms, and the filamentous forms, may well belong to a single highly pleomorphic species, though there might conceivably be a symbiotic relationship between 2 or more species which are difficult to separate in culture. Marked and somewhat similar pleomorphism has been described in actinomycetes from other sources. A technique is under development for observing and recording with photomicrographs the morphological changes of

organisms evolving from a single cell. The possible significance of these oral actinomycetes needs investigation in the light of modern concepts.

77. DENTAL CARIES IN THE SYRIAN HAMSTER. IV. THE EFFECT OF GONADECTOMY ON CARIES ACTIVITY. *Paul H. Keyes, School of Medicine and Dentistry, University of Rochester, Rochester, N. Y.* Male hamsters have been more susceptible to dental caries than female animals, especially when the carious process has been low or moderately active. To investigate this problem 20 male and 20 female animals were distributed into 4 groups of litter mates: control males (sham operated), castrated males, control females (sham operated), and spayed females. All animals were placed on a diet of low-fluoride hamster ration (1.7ppm), prepared by Purina Ralston Co., to which corn starch and powdered sugar were added. At the end of the 133 day experimental period, animals were killed and autopsied. Average caries scores were as follows: control males 62.8; control females 20.9; castrated males 9.5; spayed females 7.2. Differences in activity and growth were also observed. Males were more active than females. Gonadectomy reduced activity of males but not of females. Average body weights were: 99.8 gm, 151.8 gm, 154.9 gm, and 152.4 gm for control males and females and castrated males and females respectively. The increased body weight of males was associated with an increase in organ, skeletal, and muscle size as well as an increase in fat deposits.

78. STUDIES IN THE DIETARIES OF CONTEMPORARY PRIMITIVE PEOPLES. *Meyer Klatsky, Workman's Circle, New York.* The dietaries of a number of contemporary primitive races were studied from their nutritional as well as their textural aspects. It was found that the diets of most primitive peoples are qualitatively and quantitatively deficient in nutrient value. They are monotonous, poorly balanced, and lacking in many essential elements necessary for the normal growth and development of a healthy body. However, despite their poor nutritive level, members of the average primitive groups studied have been found to possess large, well developed jaws and healthy teeth. We feel that this is due to the physical qualities of their diet. The foods are hard, bulky, fibrous, and resistant. They stimulate function of the masticatory organs, and keep these structures in a state of health despite their unbalanced and inadequate chemical contributions. In studying dietary factors in dental abnormality and disease, more stress should be placed on the physical state and the mechanical action of foods as a functional stimulant, rather than on the chemical and nutritional aspects of the subject.

79. PHOSPHATASE IN CARIOUS LESIONS OF ENAMEL. *H. Eggers Lura and H. A. Zander, St. Elizabeth's Hospital, Denmark and Tufts Dental College, Boston, Mass.* A demonstration of phosphatase in initial carious lesions in enamel was made by the following method: A tooth was placed immediately after extraction into a solution of disodium-phenylphosphate (0.005 gr. in 50 ml. of borate buffer solution at a pH of 9.4) and incubated at 37° C for 2 hours. The phosphatases present split-off phenol which turns blue upon addition of 6 to 8 drops of a phenol reagent (Di-bromo quinon chlorimide 0.0133 gr. in 5 ml. pure methanol) in 1 ml. of purified butanol is added to the test tube. The tooth is left 24 hours in

this solution. On ground sections of teeth treated in such manner initial carious lesions appear bluish. As control the phenol reagent is added before incubation of the tooth or the tooth may be boiled for 5 minutes which destroys the enzymes. The presence of phosphatase in initial carious lesions of enamel may be of significance in caries etiology.

80. THE RELATION BETWEEN LENGTH OF MANDIBLE AND CERTAIN CHARACTERISTICS OF SKULL AND TEETH. *G. A. Montelius, University of Minnesota, Minneapolis, Minn.* Previous studies of the relation between function and form have called attention to the possible and presumed influence of a reduction of the function of the chewing muscles on the size and form of the mandible and on the skull. To test the possible effect of function on form the author studied a series of Arikara skulls, at Vermilion, S.D., and a series of Hopi skulls, in the Chicago Museum, after "sexing" the respective groups. Each sex group of these 2 series was studied as a unit, and, further, each of the 2 series was treated as a unit. The Arikara were a buffalo-hunting people, as well as an agricultural people, and had large and long skulls. The Hopi were almost exclusively a cereal-eating people, and had short, that is to say, very broad skulls. The present paper is restricted to a consideration of the relation between mandible length and certain other selected characters or dimensions, namely, skull length, circumference of outer margin of temporal muscle, height of temporal ridge above auricular orifice, antero-posterior length of temporal ridge, condylo-coronoid diameter, length of molars and premolars, length of dental arch, width of aperture of zygomatic arch, length of zygomatic arch, sagittal diameter of condyle, circumference of zygomatic arch, and transverse diameter of condyle. The relationship was tested by the Pearsonian coefficient of correlation. Each of these dimensions is positively correlated with mandible length in the Arikara group, for each sex group, and, therefore, for the entire group when sex is disregarded. In the Hopi group almost all of the correlations are lower than in the Arikara group, and, in each sex, some are negative. It was found that in the Arikara group, without regard to sex, the correlation of circumference of temporal area with circumference of zygomatic arch is .73, and for the Hopi, without regard to sex, it is .46. Each of these dimensions may be regarded as a function of size of temporal muscle, which, of course, could not be directly measured. (To be published in *J. D. Res.*)

81. PREPARATION OF SYNTHETIC SALIVA FROM DIRECT ANALYSIS OF HUMAN SALIVA. *Joseph Charles Muhler, B.S., and Henry M. Swenson, B.S., D.D.S., Indiana University School of Dentistry, Indianapolis, Ind.* Eleven patients contributed saliva for an experiment designed to measure quantitatively the important constituents of saliva. With special emphasis placed on control of diet, time and rate (amount) of secretion, factors used for stimulation, etc., a saliva was synthesized which closely approached that of the human sample. It contained in exacting proportions sulfur, 0.0076 gram; Mg as $Mg_3(PO_4)_2$, 0.0090 gram; glucoprotids in the form of mucin, 20.0000 grams; CO, NH_3, NH_4OH, N_2 and ash in the form of urea, 5.0000 gram; $NaHPO_4$, 3.0000 grams; $CaCO_3$, 3.0000 grams; KCL, 2.0000 grams; NaCl, 2.0000 grams; H_2O q. s. 5 liters. The solution was regulated with a universal buffer to an average pH of 6.9 to 7.1.

82. CONTROLLED STUDY OF THE CHARACTER AND OCCURRENCE OF CARIOUS LESIONS IN THE MOLAR TEETH OF THE SYRIAN HAMSTERS UNDER DIFFERENT DIETARY CONDITIONS. *James Nuckolls, Harry E. Frisbie and Barbara Killian, University of California, College of Dentistry, San Francisco, Cal.* The animals used in the experiment were from regular stock raised on an optimal diet. Of 6 litter mates, male and female, selected at the age of weaning (30 days), 3 were placed on a control diet consisting of fox chow, rolled oats and greens, and 3 were placed on an experimental high-carbohydrate diet (Keyes, *J. Den. Res.* **25**: 341, 1946) consisting of whole-wheat flour, corn starch, confectionery sugar, whole powdered milk and alfalfa with tap water available ad libitum. The animals were sacrificed at 10-day intervals. After fixation in 10% neutral formalin, the teeth were examined under a low-power dissecting microscope for stains, debris accumulations and plaque-like material. The experiment was repeated with 6 more litter mates, 3 of which were placed on the control diet and 3 on the experimental diet. These were sacrificed at 30-day intervals beginning when the animals were 75 days old. The teeth of all animals, control and experimental, were discolored and had debris accumulations in the occlusal pits. Microscopic carious lesions were found to the same extent in control animals and experimental animals. There was no evidence of gross lesions. From the correlation of our data there does not seem to be a higher susceptibility to caries when the animals are on this high-carbohydrate diet. A third series of animals were raised underground and were fed the normal laboratory diet. Dental plaques and evidence of microscopic caries were not generally observed in these animals.

83. EXPERIMENTAL PRODUCTION OF PERIODONTAL DISEASE IN ANIMALS FED ON A PURIFIED, NUTRITIONALLY ADEQUATE DIET. *Reidar F. Sognnaes, L.D.S., Ph.D., Harvard School of Dental Medicine, Boston, Mass.* In the course of long term dietary experiments in rats and hamsters a great frequency of periodontal lesions developed in the course of 5 to 7 months on a purified finely powdered diet containing all known nutritional essentials. The lesions were particularly frequent on the lingual surface of the mandibular molars, less so on the buccal aspect of the maxillary molars, least on the other surfaces and hardly any around the growing incisors. Grossly, pocket formation, accumulation of debris, and pathological wandering could be seen. Microscopically these findings were confirmed by definite areas of bone resorption versus deposition. The physical character of the ration may be a factor in the production of these lesions.

84. THE EFFECTS OF SCILLAREN B ON DOGS. *Henry M. Swenson, B.S., D.D.S., and Joseph C. Muhler, B.S., Indiana University School of Dentistry, Indianapolis, Ind.* Normal, healthy dogs were injected daily with 0.08 mgm Scillaren B per kilogram of body weight. The general effects were a drop of 10 to 12% in the heart rate and an emetic and diuretic action. The red count varied only slightly but the white count dropped about 4,000. Histological examination of the tissue injected with Scillaren B showed a dilatation of the capillaries. An oral examination showed a dark brown debris present on all teeth. The mouth had a foul odor, and excessive salivation existed. Crater-like lesions, averaging 10

mm. in diameter, were found in the muco-buccal fold, the tongue and buccal mucosa. Smears from these lesions, stained with gentian violet, showed an overwhelming number of fusiform and spirilla-like organisms.

85. SODIUM CARBONATE AND ITS RELATIONSHIP TO FUSO-SPIROCHETAL INFECTION IN DOGS. *Henry M. Swenson, B.S., D.D.S., and Joseph C. Muhler, B.S., Indiana University School of Dentistry, Indianapolis, Ind.* The purpose of this study was to determine whether any correlation exists between the amount of sodium carbonate in the saliva and the susceptibility to fuso-spirochetal infection in experimental animals. Dogs were given daily intravenous injections of Scillaren B, 0.08 mgm per kilogram of body weight, to produce a fuso-spirochetal infection in the oral cavity. Salivary samples were collected during the course of Scillaren B injections and examined for sodium carbonate. No correlation could be found between the amount of sodium carbonate in the saliva and the susceptibility to fuso-spirochetal infection in these animals.

86. EXPERIMENTAL PERIODONTAL POCKETS IN DOGS. *Henry M. Swenson, B.S., D.D.S., Indiana University School of Dentistry, Indianapolis, Ind.* A sharp instrument was passed down the labial root surface to sever the periodontal membrane of the canine teeth in young, healthy dogs. A copper band, fitting the cervical portion of the tooth and having a tongue or a projection extending to the base of the pocket, occupied the periodontal membrane space and served as a mechanical barrier to prevent reattachment. The band was removed in 2 weeks and the dogs were sacrificed 150 days later. Histological sections at this time showed periodontal pockets, averaging 6 mm. in depth, lined by epithelium. (Published in *J. D. Res.* **26:** 273, 1947.)

87. ESTROGEN IMPLANTS IN FEMALE DOGS: PRELIMINARY REPORT. *Daniel E. Ziskin, D.D.S., Edward V. Zegarelli, D.D.S., and Charles Slanetz, Ph.D., Departments of Dentistry and Animal Care of the Faculty of Medicine, Columbia University, New York, N. Y.* The effect of estrogen implants (alpha-estradiol) was studied in 21 female dogs with the main interest centered about oral tissue, although other organs were observed. Gross and microscopic examinations were made with complete blood counts and pertinent blood chemical analyses. Thirteen dogs received implants of alpha-estradiol subcutaneously, 3 dogs received the estrogen implants and in addition were given 3 gm. of soy bean lecithin daily incorporated into their diet, 3 dogs received estrogen implants, only, for several months, then 3 gm. of lecithin were added to their daily diets, 28 days before the termination of the experiment in 2 instances and 12 days in 1 instance and 2 dogs served as controls. The average duration of experimental procedures was 7 months. The average total dosage of alpha-estradiol was 80 mg. All animals received implants at least twice, and some as many as 5 times. The average absorption was about 170 micrograms a day. Blood counts showed a drop in the number of red blood cells and of the white cells after an initial rise. The hemoglobin showed least change. Skin changes were alopecia; a scaly dermatitis, located chiefly on exposed surfaces of joints of forelegs and hindlegs, somewhat resembling psoriasis in man; scabs between toes; and scaly sores generally over the body. Gingivae showed inflammatory necrosis characteristic of

granulocytopenia in man. Uterus presented necrosis or perforations involving the endometrium or the myometrium. Most severe necrosis developed in the uterus, the gingivae were the next most seriously involved and then the vagina. The most severe blood disturbance was a marked leukopenia. Animals receiving the soy bean lecithin were in some degree protected against the toxic symptoms, skin lesions developing later and less severely and most protection being afforded to the uterus.

XI. Executive proceedings

A. Association and council meetings

Saturday Morning Session, June, 21, 1947

The Twenty-fifth General Meeting of the Association was called to order by President Chase at 9:20 A. M., June 21st, 1947 in the Walton Room of the Drake Hotel, Chicago, Ill., for the transaction of routine business and reception of reports from committees and officers. After a brief greeting and welcome to the members and guests in attendance, President Chase called for the minutes of the previous meeting.

The minutes were submitted in the form of a reprint from the *Journal of Dental Research* as printed in the June, 1946 issue. On motion of Secretary-treasurer Hatton and in the absence of additions or corrections the minutes were approved as printed without a formal reading.

The ballot boxes for the reception of ballots for the 1947–1948 active officers were declared open and F. A. Arnold, Jr., P. P. Dale, and R. S. Manly appointed as tellers.

For the Council, the Secretary-treasurer reported that between the 24th and 25th general meetings, it had chosen the time and place of this general meeting, nominated candidates for inclusion on the current official ballot-form for active officers, had approved a budget for the operation of the office of the Secretary-treasurer for the 1946–1947 Association year of not more than $500.00, to be distributed tentatively as follows: clerical, $250; printing, $90; postage, $70; travel, $20; annual meeting, $20; without allocation, $50. The Council also authorized the remission of dues to members who have been retired to emeritus standing in their respective faculties, subject in each case to the combined approval of the Council and the section concerned, and under this arrangement remitted the dues of Peter J. Brekhus and George Montelius by unanimous votes.

The report of the Treasurer of the Committee in charge of the William J. Gies Journal of Dental Research Endowment Fund was received and read in an abbreviated form. The Committee was given an enthusiastic vote of appreciation for their interest and generous activity in promoting this project.

The Secretary-treasurer reported as follows:

Receipts for the 1946 Calendar Year

General Fund	$955.40	
Dental Art and Dental Science Fund	73.72	
William J. Gies Special Fund	47.50	
Total		$1076.62

Expenditures for the 1946 Calendar Year

Postage and mailing	$138.40	
Clerical	75.69	
Printing	128.25	
Supplies	28.57	
Travel and Hotel	67.34	
Total		$438.25

On hand as of June 1st, 1947.

General Fund, Checking Account, State Bank and Trust Co., Evanston, Ill.	$308.32
General Fund, Savings Account, #13 548	1914.54
W. J. Gies Fund, Savings and Bonds	1437.83

On motion the Secretary-treasurer's report was approved and ordered printed in the proceedings.

The Necrology Committee reported that since the last general meeting and the report as read at that time the following members had been reported as deceased: Frank Cushman, H. E. Friesell, W. C. Graham, Milo Hellman, H. E. Kelsey, Wm. F. Barnfield, A. J. Oppenheim and Samuel F. Gottlich. At the request of the President, members and guests in attendance stood briefly as a token of respect to the memory of their former colleagues and in appreciation of their contributions to the promotion of research in the oral field.

Minutes of Council Sessions

Friday, June 20th, 8:00 P.M. The meeting was called to order by President Chase. After a brief discussion and by a unanimous motion the Association was advised to affiliate with the National Society for Medical Research whose program was heartily approved and operated without expense to this Association. Remission of the *Journal of Dental Research* portion of the membership dues of the Publication Committee was voted unanimously. On motion of President-elect Hodge, without a dissenting vote, a proposal to offer two candidates for Vice-president instead of one as the Council selected candidates on the next ballot-form for active officers was adopted. After considerable discussion as to cost and labor involved a project for a new type of membership list of the directory type was approved. On motion the proposal to remit the dues of Dr. A. B. Crane of the Washington Section was approved unanimously. The motion of the Secretary-treasurer to approve dues of $5.00 per member for the 1948 calendar year with a maximum budget of the $500.00 for the operation of the Secretary-treasurer's office was carried without a dissenting vote. On motion of Vice-president Brodie a plan to permit acceptance of classified advertising by the *Journal of Dental Research*, but limited to items concerning positions for teaching and research, was approved. All plans previously tentatively adopted by the Council to promote some sort of a token session at about the time of the August meeting of the American Dental Association were cancelled. B. G. Bibby and R. F. Sognnaes were authorized to represent the Association officially at all

activities and ceremonies concerned with the August sessions of the American Dental Association.

President Chase announced his appointments of the following committees: *Council on Dental Research;* Philip Jay, Thomas J. Hill, Harold C. Hodge, Wilmer Souder and L. S. Fosdick. *Nominations to Membership;* Dean (H. Trendley), Arnim, Skinner and Hatton. *Symposium;* Armstrong, Bibby and Schour. *Foreign Sections;* Paffenbarger.

Sunday Morning Session. President Chase in the chair. Moved that the *Journal of Dental Research* share of the membership dues ($4.00) be remitted for all members residing outside of North America, payment of the balance to be made at such time as may be best suited to the needs of such members. A list of candidates for membership was approved for submission to the Association for formal election at the closing executive session. This list is printed elsewhere in these proceedings (See page 000). The Council by a formal vote indicated its very sincere and great regret at the enforced absence of William J. Gies at the current sessions because of current obligations to meet a printer's dead line, including prompt notification of this action.

Council Attendance (at one or both sessions): Mason, Jay, Dobbs, Bibby, Sicher, Hill, Kitchin (Alternate for Kaiser), Peyton, Hine, Bryan, Myers, Crawford, Speidel, Ziskin, Little, Deakins, Fleming, Bauer, Arnold, Robinson (H. B. G.), Chase, Hodge, Brodie, Hatton, Arnim, Hall.

Executive Proceedings, Sunday Afternoon Session, June 22nd, 1947

Report of the tellers was received and indicated the election of the active officers for the 1947–1948 Association year (see page 480).

On motion of the Secretary-treasurer all actions of the Council as reported by him were unanimously approved, including specifically the dues assessment of $5.00 per member for the 1948 calendar year and a budget of not more than $500.00 for the operation of the Secretary-treasurer's office, details of the budget apportionment to be approved by the Council. The expenditure of a $4.00 portion of each member's $5.00 dues assessment (if not remitted) for the support of the *Journal of Dental Research* was authorized without a dissenting vote.

On motion of the Secretary-treasurer, carried unanimously, the rules were suspended and the Secretary-treasurer directed to cast a white ballot for the election to membership of all persons on the list approved previously by the Council (see page 480).

The Council was authorized by formal vote to select the time and place of the next general meeting, and to act for the Association in the interim between this and the next general meeting.

The Secretary-treasurer submitted a vote of appreciation and acknowledgement of the aid given by many persons in the preparations for and the conduct of this meeting, particularly the staff of the Drake Hotel, the local members and the Chicago Schools who supplied and operated the projecting facilities, Miss Elson of Dr. Hall's staff and Dr. H. A. Zander for services at the registration desk, the Councillors and Editors whose attendance at this meeting set a record

which it will be difficult to surpass in the future, and all essayists who made personal sacrifices to cooperate with the program committee. Carried by a rising vote, and adjournment to Sunday Evening.

Sunday Night Session, Concluding Ceremonies

The officers for the ensuing Association year were duly inducted into their respective offices by the retiring President, Samuel W. Chase of Western Reserve University, following his own address. In the place of a formal address, Dr. Harold C. Hodge of Rochester University presented a colored film illustrating the Bikini Able and Baker Day experiments, with his own comments as an eye witness. This was followed by the formal adjournment of the Twenty-fifth General Meeting.

B. OFFICERS AND MEMBERS ELECTED

ACTIVE OFFICERS: President—*Harold C. Hodge*, Rochester University. President-elect—*Allan G. Brodie*, University of Illinois. Vice-president—*J. Roy Blayney*, Zoller Memorial Dental Clinic, University of Chicago. Secretary-treasurer—*Edward H. Hatton*, Northwestern University. Trustee (for a five year term)—*Thomas J. Hill*, Western Reserve University.

MEMBERS ELECTED: Ann Arbor, Mich.—*Byron Orville Hughes*, U. of Michigan. Bethesda, Md.—*S. Robert Howell*, Medical Research Unit, USN., *Fred L. Losee* and *Gerald Linscott Parke*, U. S. Naval Dental School. Boston, Mass.—*M. Michael Cohen*, Tufts College; *James Morse Dunning*, *Roy O. Greep*, *Anna Morse* and *James Headon Shaw*, Harvard U. Brisbane, Australia—*James Egerton Cary*, U. of Brisbane. Chicago, Ill.—*Milton B. Engel*, U. of Illinois; *Franklin J. Orland*, Zoller Memorial Dental Clinic, and *Theodore Rider*, Lever Bros. Columbus, O.—*Dorothy Permar*, Ohio State U. Copenhagen, Denmark—*Willy G. Krogh-Poulsen*. Detroit, Mich.—*Thomas L. Patterson*, Wayne U., and *Edwin S. Smyd*, private practice. Dunedin, New Zealand—*F. R. Schroff*, Otago U. Freeport, N. Y.—*Ray Carlton Brumfield*, consultation practice. Guadalahara, Mexico—*Ramon Cordova*, U. of Guadalahara. Guatemala—*Manuel H. Ortiz*, San Carlos U. Helsinki, Finland—*Per von Bernsdorff* and *Eero Tammisalo*, U. of Helsingfors. Lincoln, Neb.—*Ralph L. Ireland*. City of Mexico—*Honorata Villa Acosta*, *Felix Del Paso*, *Aurelio Galinda*, *Guillermo S. Gamboa*, *Felix R. Leycegui*, *Miguel Diaz Mercado*, *Virgilio Ramon San Miguel* and *Fernando Todd*, National University of Mexico; *Salvador Bermudez*, *Luis Mazotti* and *M. Gonzalez Rivera*, Instituto de Salubridad y Infermdades Tropicales. New York, N. Y.—*E. Alan Lieban*, private practice; *Irwin Daniel Mandel* and *Clifton A. H. Smith*, Columbia U. Ottawa, Kan.—*C. A. Scrivner*, private practice. Portland, Ore.—*Marshall L. Snyder*, U. of Oregon. Rochester, N. Y.—*J. Edward Gilda*, *David Farrar Mitchell* and *K. L. Shourie*, Rochester U. Seattle, Wash.—*Clarence Harlan Blackstone*, U. of Washington. St. Louis, Mo.—*Edward Frank Allen*, *Elias S. Khalifah* and *Leroy W. Peterson*, Washington. U. Utrecht, Holland—*O. Backer Dirks*, *M. T. Jansen* and *K. C. Winkler*, U. of Utrecht. Washington, D. C.—*Orr E. Reynolds* and *Thomas Dale Stewart*, U. S. National Museum. Zurich, Switzerland—*Eugen Dolder*, U. of Zurich. Total, 52.

C. MEMBERS VOTING AT ANNUAL MEETING

Aisenberg, Anderson (G. M.), Applebaum, Appleton, Archer, Ash, Austin, Bagnall, Bauer, Bear, Becks, Bernier, Best, Bier, Blackerby, Blackwell, Boucher, Bradley, Brashear, Brauer, Brown (J. C.), Brucker, Burket, Burwasser, Chase, Cheyney, Clawson, Clough, Cook, Cox, Coy, Crawford, Dahlberg, Dale, Darlington, Davis, Dean (H. T.), Dean (Marguerite), Dietz, Dobbs, Dummett, Easlik, East, Easton, Elvove, Epstein (S.), Erikson, Fairbank, Finn, Fleming, Fosdick, Fox, Freeman (C. W.), Gabel, Gilkison, Goldman,

Gottlieb, Grossman, Gruebell, Hadley, Hahn, Hartley, Hatton, Hill, Hodge, Hoffman, Holliday, Hooper, Hubbell, Jarabak, Jordan, Kaiser, Kazanjian, Karshan, Keilty, Kerr, Keyes, Keys (D. A.), King, Kitchin, Klaffenbach, Klatsky, Klein, Kniesner, Knutson, Koch, Krasnow, Krogh, Kurth, Lalonde, Lazansky, Lefkowitz, Leonard, Levy, Lewis, Lovestedt, Lowery, Main, Manly, Mann (A. W.), Margolis, Massler, McBride, McCall, McCauley, McCrea, Mead, Merkeley, Miller (S. C.), Moore (G. R.), Mueller (A. H.), Mueller (Emil), Myers (R. A.), Nelson (C. A.), Neuwirth, Noyes (F. B.), Noyes (H. J.), Nuckolls, Oblatt, Oliver (O. A.), Orban, O'Rourke, Paffenbarger, Peyton, Phillips, Podolin, Pomes, Prinz, Purcell, Rault, Revesz, Ritchey, Rittershofer, Robinson (J. Ben), Romnes, Rosenstein, Rudolph, Ryder, Salzman, Sarnat, Scherer, Schour, Shell, Sicher, Simon, Simmonds, Skillen, Skinner, Sloman, Sognnaes, Sorrin, Speidel, Stafne, Steadman, Stein (G.), Sweeney (J. T.), Sweet, Taber, Tanchester, Taylor (W. E.), Teuscher, Thompson (H. S.), Thompson (J. R.), Tilden, Treloar, Van Huysen, Volker, Volland, Wach, Waldron, Wallace, Ward, Waugh, Weinmann, Wheeler, Willett, Williams (N. B.), Willman, Wolfe, Wright, Wylie (W. L. Jr.), Younger, Zander. Total, 183.

D. MEMBERS IN ATTENDANCE AT ONE OR MORE SESSIONS, LISTED BY SECTIONS

Ann Arbor—Bunting, Crowley, Easlik, Jay, N. O. Taylor. *Baltimore*—Aisenberg, Dobbs, Hahn, McCrea, J. Ben Robinson. *Boston*—Bibby, Glickman, Manly, Margolis, Marjerison, Sognnaes, Volker, Zander. *Chicago*—Blackwell, Blayney, Bradel, Brodie, Calandra, Claflin, Coolidge, Cooper, Denton, Fosdick, C. W. Freeman, Gruebbel, Hatton, Jarabak, Kesel, Kurth, Lasater, Massler, F. B. Noyes, Orban, Pomes, Pendleton, Rapp, Sarnat, Schour, Shell, Sicher, Skillen, Skinner, Steinmeyer, Teuscher, J. R. Thompson, Tilden, Tylman, Wallace, Wassermann, Weinmann. *Cleveland*—Burwasser, Chase, Hill, Kniesner, W. L. Wylie, Sr. *Columbus*—Arnim, Kitchin, Rabkin, H. B. G. Robinson. *Houston*—F. C. Elliott, Peyton. *Indianapolis*—Hall, Hine, Koss, Phillips, Swenson, Swenson Van Huysen. *Iowa City*—J. D. Boyd, Bryan, Cheyne, Easton, Higley, Klaffenbach, Lovett, Smith. *Louisville*—Burrill, Myers, W. M. Randall. *Minnesota*—Crawford, Lovestedt, Lund, Ray, Simon. *New Orleans*—Fisher, Speidel. *New York*—Bevelander, East, Kreshover, Leonard, McCall, S. C. Miller, Neuwirth, Rosebury, Wright. *Philadelphia*—Crowell, Gore. *Pittsburgh*—W. F. Swanson, W. T. Sweeney. *Richmond*—Bear, Clough, Little, Lyons. *Rochester*—Dale, Deakins, Hodge. *San Francisco*—Fleming, Sloman, Wainwright, W. L. Wylie, Jr. *St. Louis*—Bauer, Boling, Brady, Brandhorst, Dietz, Gurley, Jasper, Knighton, Levy, Main, Wood. *Washington*—Arnold, Bernier, Caul, H. T. Dean, Erikson, Hampp, McCauley, McClure, Paffenbarger, Rault, Schoonover, D. B. Scott, Stephan. *Tennessee*—Clawson. *Toronto*—Mason. *Chengtu*—Agnew. *No Section Membership*—Atkinson, Coleman, Finn, Gottlieb, Hooper, D. A. Keys, Molnar, T. E. Moore, C. A. Nelson, H. J. Noyes, Powell, Simmons, Sweet, Tainter, P. B. Taylor, Winter, Younger. Total, 160. Total number of registered guests, 148. Total recorded attendance, 308. Attendance at the Sunday Evening Dinner, 128.

SUPPLEMENT

I. Journal of Dental Research Sustaining Subscribers, 1947

Dr. Ernest N. Bach
Toledo, Ohio

Dr. Arthur E. Corby
New York, N. Y.

Dr. J. T. Gore
Philadelphia, Pa.

Dr. E. H. Hatton
Chicago, Illinois

Dr. Alfred L. Kohn
New York, N. Y.

Dr. D. M. Milne
Portland, Me.

Dr. Roy J. Rinehart
Kansas City, Mo.

Dr. Isaac Schour
Chicago, Illinois

II. International Association for Dental Research

Membership lists, including addresses of North American members and section rolls. This material is printed annually in the December number of the Journal of Dental Research.

Compiled by Edward H. Hatton, *Secretary-Treasurer*

REGISTER OF MEMBERS

1. North American Members

Honorata Villa Acosta, Plaza del Colegio de Ninas, #2 Desp. 3, Mexico, D. F.
M. S. Aisenberg, 20, Dental School, U. of Maryland, Baltimore 1, Md.
E. F. Allen, 10, 4559 Scott Ave., St. Louis, 10, Mo.
G. M. Anderson, 20, 831 Park Ave., Baltimore 1, Md.
B. G. Anderson, 2, Medical School, Yale U., New Haven, Conn.
Edmund Applebaum, 1, 630 West 168th St., New York 32, N. Y.
J. L. T. Appleton, 8, Dental School, U. of Pennsylvania, Philadelphia 4, Pa.
W. H. Archer, 9, Professional Bldg., Pittsburg 22, Penna.
W. D. Armstrong, 7, Medical School, U. of Minnesota, Minneapolis 14, Minn.
S. S. Arnim, 31, Dental School, U. of Texas, Houston 4, Texas
F. A. Arnold, 17, National Institute of Health, Bethesda 14, Md.
H. E. Ash, 17, Army Medical Museum, Washington 25, D. C.
H. H. Asher, 3, 55 E. Washington St., Chicago 2, Ill.
S. R. Atkinson, 60 N. Madison Ave., Pasadena 1, Cal.
L. T. Austin, 7, Mayo Clinic, Rochester 1, Minn.

*L. W. Baker, 2, 230 Beacon St., Boston 15, Mass.
J. S. Bagnall, 11, Dental School, Dalhousie U., Halifax, Nova Scotia
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William H. Bauer, 10, 3556 Caroline St., St. Louis, Mo.
J. R. Beall, 17, National Bureau of Standards, Washington 25, D. C.
Harry Bear, 22, Dental School, Medical College of Virginia, Richmond, Va.
R. J. Bean, 11, Medical School, Dalhousie U., Halifax, Nova Scotia
Hermann Becks, 6, Hooper Foundation, U. of California, San Francisco 22, Cal.
*Adolph Berger, 1, 654 Madison Ave., New York 21, N. Y.
Harold Berk, 2, 471 Commonwealth Ave., Boston 15, Mass.
M. C. Berman, 18, Dental School, Ohio State U., Columbus 10, Ohio
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Gerrit Bevelander, 1, 477 First Ave., New York 16, N. Y.
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P. E. Blackerby, Kellogg Foundation, Battle Creek, Mich.
C. H. Blackstone, School of Dentistry, U. of Washington, Seattle 5, Wash.
R. E. Blackwell, 3, 180 N. Michigan Ave., Chicago 1, Ill.

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* Charter member.

J. R. Blayney, 3, 950 East 59th St., Chicago 37, Ill.
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Philip Burwasser, 14, Dental School, Western Reserve U., Cleveland 6, Ohio

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* Charter member.

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7. Minnesota
8. Philadelphia
9. Pittsburgh
10. St. Louis
11. Halifax
12. Vienna
13. New Haven (discontinued, 1940)
14. Cleveland
15. Winnipeg
16. London
17. Washington
18. Columbus
19. Louisville
20. Prague
21. Baltimore
22. Richmond
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[1] A number following a name indicates membership in a section as shown in the key to the sections immediately preceding this list.

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Total membership as of Nov. 5, 1947—636.

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[1] Members of the Materials Group may and in most instances do belong to Sections.

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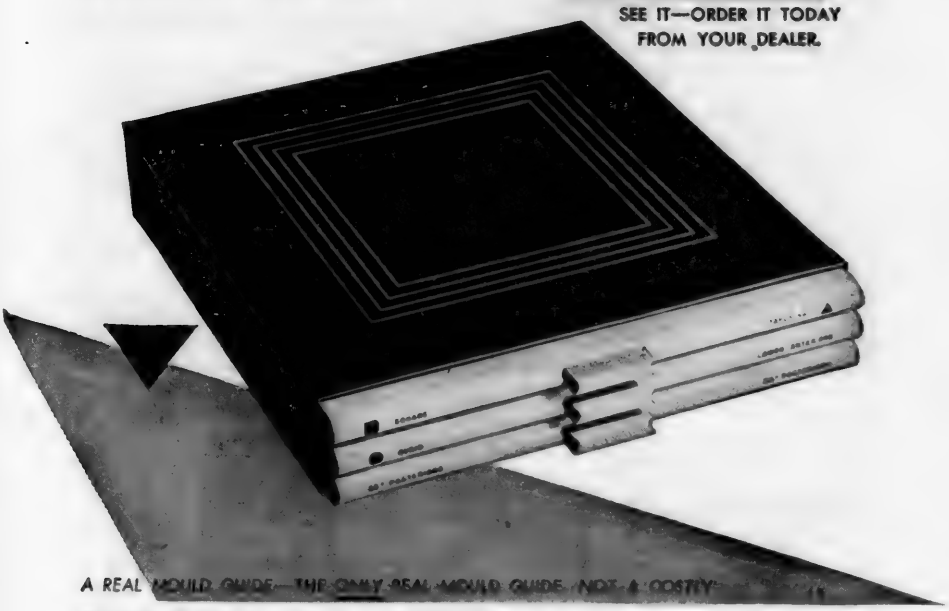

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General Meetings have been held on this schedule: (1) New York, Dec. 21, '22. (2) Chicago, Mar. 7, '24. (3) Chicago, Mar. 20, '25. (4) Chicago, Mar. 26, '26. (5) New York, Apr. 19, '27. (6) Washington, Mar. 25–28, '28. (7) Chicago, Mar. 23–24, '29. (8) Toronto, Mar. 24–26, '30. (9) Memphis, Mar. 21–22, '31. (10) Columbus, Mar. 19–20, '32. (11) Chicago, Mar. 18–19, '33; adjourned executive session, New York, May 25, '33. (12) Chicago, Mar. 17–18, '34. (13) Chicago, Mar. 16–17, '35. (14) Louisville, Mar. 14–15, '36. (15) Baltimore, Mar. 13–14, '37. (16) Minneapolis, Mar. 12–13, '38. (17) Cleveland, Mar. 18–19, '39. (18) Philadelphia, Mar. 13–14, '40. (19) St. Louis, Mar. 15–16, '41. (20) New York, Mar. 14–15, '42. (21) Chicago, Mar. 13–15, '43. (22) Chicago, Mar. 18–19, '44. (23) Chicago, May 27, '45. (24) Kansas City, Mar. 16–17, '46. (25) Chicago, June 21–22, '47.

Objects (Const., Art. II): . . . "(a) To promote broadly the advancement of active research in all branches of dental science and in related phases of the sciences that contribute directly to the development of dentistry, and which add to the knowledge of the mouth and teeth and of their relations to the body as a whole; . . . (b) to encourage and facilitate coöperative effort and achievement by, and mutual helpfulness among, investigators in all nations in every division of stomatology; (c) to the end, particularly, that dentistry may render cumulatively more perfect service to humanity." (The Association has been using "dentistry" and "stomatology" as synonyms.)

Membership: total (Nov. 10, 1946), 627. *Eligibility (Const., Art. 14, Sec. 1).*—"Any person who has conducted, and published an account of, a meritorious original investigation in dental science, or in any of the sciences contributory to stomatology, shall be eligible to membership in this Association, providing such person conforms to the recognized standards of professional ethics." *Election.*—New members may be elected *only at general meetings of the Association.* Membership in a section is secondary to membership in the Association as a whole. Removal of members from one geographic center to another does not affect their membership in the Association.

Endowment fund of the International Association for Dental Research (as of Mar. 16, 1946): $1,402.98. There have been no expenditures from this fund.

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